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DAVID A. HAUKOS AND LOREN M. SMITH

Front cover: Cover illustration of *Polygonum amphibium L.*, commonly know as water smartweed, was prepared by Anna Lovering of Lubbock, Texas. The specimen was collected in 1995 during a comprehensive study of plant communities in playa wetlands of the Southern Great Plains.

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Plant Communities of Playa Wetlands in the Southern Great Plains

David A. Haukos and Loren M. Smith

Abstract

Playa wetlands are keystone ecosystems critical to the existence of native flora and fauna in the High Plains portion of the Southern Great Plains. Further, they are the sole recharge points for the southern portion of the Ogallala Aquifer, without which human habitation of the region would be minimal. Because of the importance of playas to the existence of life in the region, understanding and appreciation of their ecology is necessary to document and predict landscape changes affecting biodiversity and human inhabitation of the Southern Great Plains. Unfortunately, little is known about the basic playa ecology leading to a lack of understanding of what is being lost as these unique wetlands disappear. Because plants are the basis to a productive and functioning ecosystem, documenting playa flora is the necessary first step in establishing an ecological baseline that can be used in the future to accurately monitor changes in the ecology of playas. We documented playa flora community composition using step-point transects in 233 playas of northwestern Texas, eastern New Mexico, Oklahoma panhandle, southwestern Kansas, and southeastern Colorado - the designated Playa Lakes Region (PLR). We evaluated the influence of season (warm vs. cool), surrounding watershed type (crop vs. grassland), and disturbance (i.e., seasonal change in soil moisture) on flora diversity, community composition, and species frequency. Patterns of community composition were identified based on correspondence analyses at the playa and county scales for all, cropland, and grassland playas. Cluster analyses of ordination scores at the county scale were used to identify spatial associations of playas to discover potential landscape gradients influencing occurrence and distribution of associated floras. Additional cluster analyses were used to identify species associations.

We identified 197 species in the extant vegetation of sampled playas (172,599 step-point samples), adding 64 species to the previously reported 282 species in playa wetlands for a total of 346 species potentially occurring in playas of the PLR. Species richness was similar between watershed types and seasons and among disturbance and soil moisture categories. Flora diversity was similar between watershed types and between seasons. The lack of differences in species richness and diversity values reflect the relatively simple topography of playas that limit the number of niches available despite differences in individual playa size, season, soil moisture, location in the landscape, and surrounding watershed. Only a few species (28 of 197) were identified that contributed to spatial differences in communities among playas. At the county scale, groupings of ordination scores reflected the landscape gradients of growing season and precipitation, with changing flora species occupying the same niches as one traverses the entire region. Using common species (> 5% frequency), we identified 12 species associations within playas.

The primary process that contributes to the establishment and persistence of playa flora is the natural fluctuations of water levels that defines playa hydrology. Long-term stabilization of a playa environment eliminates the dynamic flora of the wetland and destroys playa ecology. The overwhelming threat to playa flora is filling of the wetland by sediment eroded from the surrounding watershed, which alters playa hydrology and buries playa seed banks, which are the principal source of propagules that allows the flora to respond to the dynamic environment. To conserve 100 native plant species, protection of at least 100 - 125 playas is necessary. Given that less than 20 playas are currently protected in the PLR, conservation efforts to date are insufficient to ensure future viability of playa ecosystems.

INTRODUCTION

Playa wetlands are keystone ecosystems of the High Plains portion of the Great Plains. These depressional recharge wetlands are most numerous in the delineated 360,000 km^2 Playa Lakes Region (PLR) of the shortgrass prairie of southeastern Colorado, southwestern Kansas, Oklahoma panhandle, eastern New Mexico, and northwestern Texas (Figure 1). The highest density of playas in the PLR is on the Southern High Plains (SHP; 1 per 2.6 km^2) or *Llano Estacado* of Texas and New Mexico, the largest isolated plateau in the Western Hemisphere (130,000 km^2). The SHP is bounded by abrupt escarpments adjacent to the Canadian River to the north, Pecos River to the west, and the Caprock Escarpment formed by headwater erosion of the Red, Brazos, and Colorado rivers to the east, with a less distinct gradation into the Permian Basin and Edwards Plateau to the south (Holliday 1991). On the SHP, playas are the most significant topographical expression and surface hydrological feature (Haukos and Smith 1994a).

Numbers of playas within the PLR have been estimated between 25,390 and 37,000 (Reddell 1965; Guthery and Bryant 1982; Osterkamp and Wood 1987). Most governmental agencies use the estimate of 25,390 playas for the PLR, of which 21,800 are located in the SHP (Guthery and Bryant 1982). Average playa size in the PLR is 6.3 ha with 87% of playas being less than 12 ha (Guthery and Bryant 1982). Playa size increases from southwest to northeast, similar to the regional precipitation pattern (Grubb and Parks 1968; Allen et al. 1972). Of the 36.4 million ha of the PLR, approximately 160,000 ha are playa wetlands. On the SHP, playas occupy only 2% of the landscape (120,270 ha; Haukos and Smith 1994a).

These shallow (typically <1 m deep based on hydric soil) depressional wetlands provide numerous functions critical to the persistence of flora, fauna, and humans in the region. Serving as camping sites for historical travelers and initial settlement locations, playas provided the necessary goods and materials for the first humans on the seemingly uninhabitable Southern Great Plains (Bolen and Flores 1986). As the primary drainage area for the SHP, playas collect and store precipitation runoff for greater than 90% of the region (Nelson et al. 1983). Playas are critical recharge points for the underlying Ogallala Aquifer, filtering and recharging 20-80% of collected water to the aquifer (Osterkamp and Wood 1987; Wood and Osterkamp 1987; Zartman 1987; Zartman et al. 1996); thus they are vital for the continued maintenance of the aquifer, without which human habitation of the region would be limited. Runoff stored in playas is used as a source for livestock and irrigation water. Many playas also serve as catchment and storage reservoirs for wastewater runoff from industrial, municipal, and confined-animal feedlot sources (Haukos and Smith 2003). Playas provide considerable livestock forage, especially in periods of prolonged drought. Finally, and most critically, in one of the most intensive agriculturally-impacted regions of the world, playas serve as islands of biodiversity providing the majority of remaining native wildlife habitat and refugia for native plants (Haukos and Smith 1994a).

Playas are usually associated with a hydric, montmorillonite or illite clay (Allen et al. 1973). Randall clay (fine, smectitic, thermic Ustic Epiaquerts) or a close series relative are the predominant soils in playas (Luo et al. 1997, 1999). These soils are very different from the adjacent upland fine sandy loams or clay loams in color and texture. Measurements of the hydric soil typically result in describing a playa as a circular basin (Luo et al. 1997). Further, a playa can also be defined by its relative position in the landscape. Playas are characterized as the terminus of closed watersheds, with few documented surface connections among adjacent playas. Typically, as one descends into a playa, the wetland edge can be distinguished by a distinct change in watershed slope from the relatively shallow upland slope to a short, steeper slope leading into the playa floor. The playa floor is flat, lacking the depth contours found in most other freshwater wetlands. Therefore, physical structure of playa ecosystems is rather simple compared other wetlands; playas have two dominant environments - the sloping edge and level floor (Smith and Haukos 2002).

Closed watersheds that define playas result in a uniqueness among playas not found in many wetlands systems. Each playa is the center of an isolated ecosystem rarely physically impacted by neighboring playas and driven by hydrologic, ecomorphic, and an-

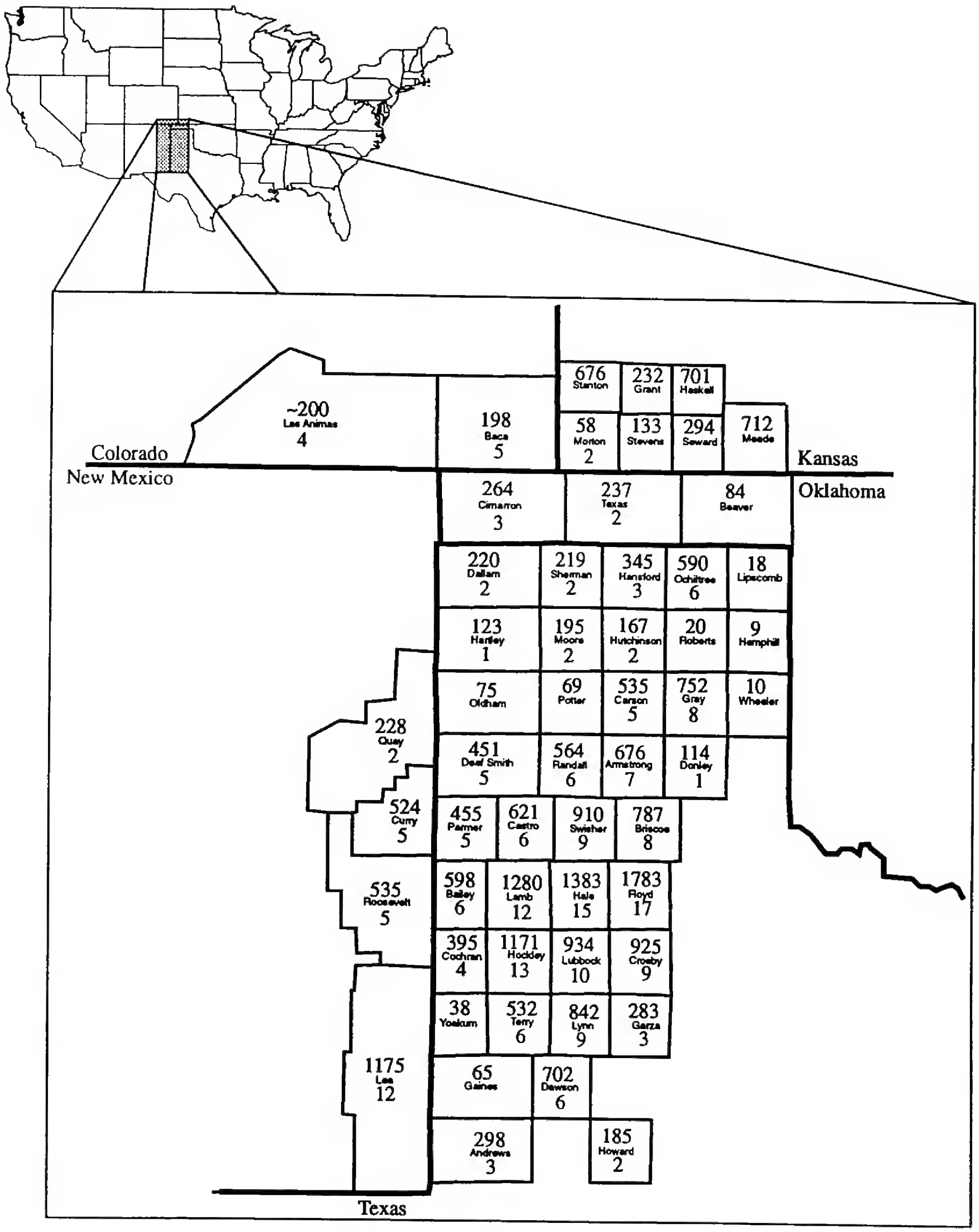

Figure 1. The Playa Lakes Region of the High Plains in the Southern Great Plains of Colorado, Kansas, Oklahoma, New Mexico, and Texas. The larger number associated with each county indicates the number of playas based on Guthery et al. (1981); the smaller number indicates the number of playas sampled in 1995 for plant species occurrence and community composition.

thropogenic events confined to its watershed. Ecosystem processes are primarily influenced by a dynamic, unpredictable, and rarely stable hydroperiod, the result of infrequent, isolated precipitation runoff events, lack of a direct ground-water connection, and very high potential evaporation rates (Smith 2003).

Typically, a playa will experience flooding and drying at least one or more times during a growing season. Generally, playas fill via runoff from intense thunderstorms, which are most prevalent from May-June and September-October, but the semiarid nature of the PLR frequently results in extended dry periods in these systems. As the environment changes, different flora niches appear and disappear over potentially short periods of time (Haukos and Smith 1997). In dry and moist-soil conditions, plants species can exploit a variety of niches usually based on levels of soil moisture. When a playa floods, the number of niches are few. The primary variable affecting the presence of a plant species is the length of flooded conditions (Haukos and Smith 1992). However, several anthropogenic changes to the playa ecosystem have altered the natural hydrology of these wetlands by impacting available niches and thus entire plant communities (Smith and Haukos 2002).

Following development of deep-well technology after World War II, the Ogallala aquifer was heavily tapped for irrigation purposes. From the 1950s through the 1980s, water conservation efforts were minimal and resulted in the artificial flooding of many playas via directed irrigation runoff (i.e., tailwater). As a result, many playas had artificially altered hydroperiods that allowed the establishment and colonization of hydrophytic plant species not found at other times. However, since the late 1980s changing irrigation technology and mandatory water conservation practices have limited filling of most playas to only rainfall runoff. Additionally, playas in cultivated areas receive and accumulate sediment that cause a reduction in hydroperiod relative to grassland areas (Luo et al. 1997, 1999). These conditions have influenced the community composition of the flora in many playas (Smith and Haukos 2002). Concurrent with the increase in irrigation throughout the region, pits were excavated into or adjacent to approximately 70% of playas greater than 4 ha for the purpose of recycling both precipitation and irrigation runoff back onto farm fields (Guthery et al. 1982). Excavation modifications drastically changed the playa ecosystem by reducing the amount of littoral area (i.e., most of the playa experiences increased frequency of dry conditions) and providing a small area (i.e., the pit) of nearly permanent water (Bolen et al. 1989).

Other impacts affecting playa vegetation include their use for collection and storage of waste- and stormwater that usually results in a vast reduction in native plants. Further, throughout much of the PLR many of the smaller playas have been completely filled either intentionally for cultivation purposes or with eroded sediment from surrounding farm fields (Luo et al. 1997, 1999).

Native plant communities within and among playas have been further degraded or eliminated due to intensive grazing pressure or cultivation. Guthery and Bryant (1982) found that 43% of smaller playas had been cultivated. Guthery et al. (1982) also estimated that 75% of playas were cropped or disced for weed control. Estimates of the extent of grazing is 25-50% for all PLR playas (Guthery et al. 1981; Guthery et al. 1982; Guthery and Stormer 1984). Therefore, few playas have escaped influence by livestock grazing or cultivation with many subjected to both. Furthermore, with the creation of the Conservation Reserve Program (CRP) by the United States Department of Agriculture (USDA) in 1985, which assists farmers by paying for a portion of perennial cover establishment and an annual rental fee to take highly erodible land out of production, a number of exotic grasses have been introduced into the SHP and playas (e.g., *Eragrostis curvula*, varieties of *Bothriochloa ischaemum*, and *Panicum coloratum*). The SHP has the highest density of CRP in the nation (Berthelsen et al. 1989). Despite changing requirements by USDA to plant only native species during CRP reenrollment or new establishments since 1996, vigor of the previously planted exotic species has hindered these efforts (D.A. Haukos, personal observation).

Therefore, during the past 50 years considerable changes have occurred in nearly all playa ecosystems. Unfortunately, there are no baseline ecological data with which to compare the current structure and function of playa ecosystems. Given the critical importance of playas in the overall health of Great Plains ecosystem,

it is vital to establish a basic ecological understanding of these wetlands to accurately monitor their future responses to such landscape scale events as changing agricultural operations, increasing human populations, and global warming. Moreover, disturbance is an important factor in the development of plant communities (Rosenzweig 1995; Baldwin and Mendelssohn 1998). Disturbance in playas can result from herbivory, cultivation, fire, and changing soil moisture resulting from the unpredictable precipitation events and altered hydroperiods. Evaluation of the influence of disturbance will provide additional insight into the development of playa plant communities. Documentation and analyses of floral dynamics, composition, and distribution throughout the PLR is the initial necessary step in establishing an ecological understanding of playa wetlands.

Compared to other inland freshwater wetlands, there have been few investigations of playa floras. Reed (1930) described 25 plant species in playas and noted that playa vegetation differed from that of the surrounding upland. Rowell (1971, 1981) listed 69 species occurring in playas. Evaluating both soil seed banks and extant vegetation, Haukos and Smith (1993) added 17 more species, many of which would have been expected in the native prairie surrounding playas. Combining these published reports with unpublished plant surveys of Hoaglund (1991) in Colorado, Curtis and Beierman's (1980) regional study, Cushing et al. (1993) and Johnston (1995) on the Department of Energy's Pantex Reservation near Amarillo, Texas, and two reports from Kansas (Kindscher and Lauver 1993; Kindscher 1994) gives a total of 282 species previously reported from playa wetlands in the PLR (Haukos and Smith 1997).

Data on ecological attributes of playa flora in the PLR other than species occurrence are restricted to a small number of playas. Numerous ecological characteristics of seed banks in playas have been documented including composition (Haukos and Smith 1993a), influence of disturbance (Haukos and Smith 1992), relationships to field vegetation (Haukos and Smith 1993), distribution along the elevational gradient (Haukos and Smith 1994b; Hoaglund and Collins 1997), and temporal emergence patterns (Haukos and Smith 2001). The influence of soil moisture on photosynthesis and seed production of *Polygonum pensylvanicum* was documented by Smith and Haukos (1995). Invertebrate (Haukos 1992) and native vertebrate (Smith 1988) herbivory patterns have been reported. Haukos and Smith (1993b, 1995) evaluated the effects of wetland management on species composition and nutritional characteristics of seeds from a waterfowl perspective. Using data from this study, Smith and Haukos (2002) documented specie's-area relationships and the impact of watershed landuse on playa flora throughout the PLR; the first study examining plant communities throughout the PLR.

Attempts have been made to identify plant associations within playas. Reed (1930) identified three vegetation associates identified by dominants *Ambrosia grayi* - *Marsilea vestita*, *Vernonia marginata* - *Lippia nodiflora*, and *Buchloë dactyloides*. Penfound (1953) identified 13 vegetation associations in playas; nine of which were also reported by Hoaglund and Collins (1997). Guthery et al. (1982) listed 14 physiognomic types in playas. However, eliminating the cultivated and road-pit types (2 with no listed plant species) leaves 12 vegetation types (Guthery et al. 1982).

Unfortunately, with the exception of Smith and Haukos (2002), the previous studies are based on data from a limited geographical area compared to the rather large Southern Great Plains; thus, limiting the ability to describe general floral attributes of playas because of the scale at which the data were collected. Therefore, accurate representation of plant communities in all playas requires study throughout the Southern Great Plains. Specifically, knowledge of spatial and temporal variation of plant communities in association with surrounding land use, soil moisture, and disturbance regimes have applied and theoretical applications. Isolation of playas provides opportunity to examine discrete floral responses to environmental changes. The objective of our study was to examine plant community ecology in playas across the Southern Great Plains relative to land use, disturbance, and temporal and spatial variation. This information will form a cornerstone in the understanding of plant dynamics in playa wetlands. Following the description of plant communities, we will provide an estimate of the number of playas necessary to be protected for conservation of plant species in playas throughout the PLR.

METHODS

The study area was the high plains portion of the Southern Great Plains (Figure 1), which is semiarid and transitory between the Chihuahuan Desert to the southwest and the mesic prairies to the north and east. The ancient cool and wet climate of the region changed during the Holocene (6000-4500 years BP) to warm and dry (Holliday 1991). Currently, the climate is subhumid continental, with an average annual precipitation range of 33 cm in the west to 63 cm in the east. Precipitation occurs primarily as heavy, localized thunderstorms during May through September (Bolen et al. 1989). Drought is a natural, unpredictable, and common occurrence (Holliday 1991). Temperature fluctuates widely and frequently, with recorded temperatures of -4 C to above 50 C. Average annual potential evaporation can exceed 250 cm per year, especially in the southern areas (Bolen et al. 1989). The growing season averages 140 days in the north to 220 days in the south.

In 1995, we randomly selected 1% of the playas in all counties that had greater than 100 playas in each of the five states of the PLR (Figure 1). Only two playas were surveyed in Kansas because we were unable to locate playas that had not been filled or cultivated or obtain landowner permission for access to suitable playas. We determined plant species occurrence in 233 playas using step-point sampling (Bonham 1989) with species recorded approximately every 1 m along two transects. The first transect was initiated in the southeast corner of the playa proceeding at a 45 degree angle to the west side of the basin. The second transect was initiated on the west side of the playa and proceeded at a 45 degree angle to the northeast edge of the basin. We determined the playa edge by examining changes in soil color and slope. Because playas are circular, each transect was approximately equal in length. Further, each playa was searched following transect counts for the presence of any species not found on the transects.

We determined plant species occurrence twice for 224 of the 233 playas to account for cool and warm season species; late spring-early summer (15 May-30 June) and mid-late summer (15 July-31 August). The nine playas not sampled twice, due to cultivation between surveys, are only included in data summaries. Statistical analyses were conducted on data collected from the 224 playas sampled twice during the growing season. We started each sampling period in the southern portion of the region, working north, to account for the variation in growing season within the region.

We followed the Flora of the Great Plains (Great Plains Flora Association 1991) for nomenclature. Plants were identified using the Great Plains Flora Association (1991), Correll and Johnston (1981), and Godfrey and Wooten (1983). All known species were identified in the field with collection of voucher specimens for verification. Unknown species were collected for future identification. Voucher specimens are available in the herbariums of the Department of Range, Wildlife, and Fisheries Management and Department of Biological Sciences at Texas Tech University.

The dominant (>50%) land use of the watershed surrounding each sampled playa was classified as cropland (annual cultivation) or perennial grassland. Sampled playas surrounded by perennial grasses established through the Conservation Reserve Program were classified as cropland because of the previous exposure to intensive cultivation and associated sedimentation. The soil moisture condition of each playa was qualitatively categorized prior to each survey as flooded (standing water over >50% of the playa floor), moist (standing water over <50% of playa floor or sufficient topsoil moisture to form and maintain a soil ball), or dry (insufficient topsoil moisture to form a soil ball). Frequency, as percent of playas in which the species was found, and percent community composition were calculated for each land use, soil moisture category, season (early or late), and overall (across sampling seasons).

Three measures of diversity were calculated. Species richness was calculated as the total number of species identified in each playa along the transects and during the subsequent wetland survey following transect completion. The number of points a plant species was encountered along transects was used as the number of individuals in calculation of Shannon's and Simpson's diversity calculations (Magurran 1988). We used both indices because of the different influ-

ence of rare species on the value of the index (i.e., increased importance for Shannon's compared to Simpson's; Magurran 1988). To be consistent with increasing values equating to increasing diversity, we present Simpson values as 1-SI.

Disturbance was categorized based on changes in soil moisture from the early season to the late season surveys. Disturbance was classified as high when the soil moisture categories changed from dry to flooded or flooded to dry. Intermediate disturbance was classified as a slight soil moisture change (e.g., moist to flooded, dry to moist, flooded to moist, moist to dry). Low disturbance was represented by no change in soil moisture.

Patterns of community composition were identified based on correspondence analyses at the playa scale for all, cropland, and grassland playas. Seasonal and overall analyses were conducted for all playas. We also conducted the analyses at the county scale. Analyses were conducted for all species and just common species (i.e., > 5% frequency). Scores from the first three dimensions were plotted to examine patterns of species occurrence and identify those species that contributed most to differentiation of playas or counties based on community composition of plants (Gauch 1983). Spatial associations of playas at the county level were identified with Ward's minimum variance cluster analyses of the correspondence scores. Species associations were identified based on Ward's minimum variance cluster analyses of the correspondence scores. Therefore, examination of correspondence scores occurred at two scales: (1) relationships among individual dimensions to identify potential gradients contributing to changes in the plant community (i.e., a single dimension) and (2) combining the orthogonal dimensions through cluster analyses of multiple dimensions to simultaneously group similar spatial occurrence of communities and species associations (i.e., multiple dimensions).

Playa size was compared between land use types with a t-test. Analysis of variance (ANOVA) was used to compare playa size among ordination groups and disturbance categories. We also used ANOVA to test mean values of species richness, Shannon's index, and Simpson's index among ordination groups, disturbance categories, soil-moisture condition, and between land uses. A chi-square test was used to compare the frequency of playas among disturbance categories within land uses.

RESULTS

We completed 457 playa surveys (224 playas twice and 9 once). Of these, 303, 49, and 105 surveys were in dry, moist, and flooded conditions, respectively. A total of 172,599 step-point samples was recorded; 61.2, 10.4, and 28.3% in dry, moist, and flooded playas, respectively (Table 1). Of the playas surveyed twice, cropland was the land use surrounding 126 of the wetlands (56.3%). Playas did not differ in area ($t_{222} = 0.44$, $P = 0.66$) between land uses (cropland = 15.4 ha, SE = 1.3; grassland = 14.5 ha, SE = 1.7).

We identified 178 plant species during transect sampling with another 19 species found in playas but not on a transect (Appendix I). Seventy-one species occurred in >5% of the playas and were considered common species in later analyses. Unidentifiable individuals accounted for 1.1% of the step-point samples. Points without vegetation (soil/water) and dead vegetation (e.g., litter) were recorded on 15.3 and 5.8% of the samples, respectively (Appendix I). Frequency of occurrence (percent of playas) and percent community composition of most species varied across land uses (total and seasonal) and soil moisture categories (Appendices II and III).

Diversity - Overall and seasonal species richness was similar between watershed types (overall $t_{222} = 0.065$, $P = 0.52$; seasonal $t_{222} = 0.44$, $P = 0.66$; Table 2). Shannon's diversity index was higher ($t_{222} = 2.77$, $P = 0.006$) in cropland playas than grassland playas (Table 2). None of the diversity measures differed between early and late season periods ($t_{446} = 0.85$ - 1.28, $P = 0.20$ - 0.39; Table 2). Although average species richness did not differ among soil moisture categories ($F_{2,454} = 1.5$, $P = 0.18$), both diversity indices did (Simpson's $F_{2,454} = 5.69$, $P = 0.0036$, Shannon's $F_{2,454} = 5.12$, $P = 0.0063$; Table 2). Diversity was

Table 1. Number of surveyed playas, ordination codes, and number of sampling points in 3 soil moisture conditions (dry, moist, flooded) during 2 sample periods (early, late) in 40 counties and 5 states (Texas, New Mexico, Oklahoma, Kansas, and Colorado) of the Playa Lakes Region. The ordination codes are a reference for county abbreviations plotted on the ordination diagrams (Figure 8).

					Sample Points					
	Ordination	# of Surveyed Playas			Soil Moisture			Season		
County, State	Code	Early	Late	Total	Dry	Moist	Flooded	Early	Late	Total
Andrews, TX	AND	3	3	3	1120	218	0	634	704	1338
Armstrong, TX	ARM	7	7	7	3226	229	2138	2614	2979	5593
Baca, CO	BAC	5	5	5	2620	0	0	1203	1417	2620
Bailey, TX	BAI	6	6	6	3564	0	0	1771	1793	3564
Briscoe, TX	BRI	8	8	8	3087	0	2047	2329	2805	5134
Carson, TX	CAR	5	5	5	4636	1700	622	3583	3375	6958
Castro, TX	CAS	6	6	6	3194	488	2039	2819	2902	5721
Cimmaron, OK	CIM	3	3	3	3425	0	230	2230	1425	3655
Cochran, TX	COC	4	4	4	1209	0	539	840	908	1748
Crosby, TX	CRO	9	9	9	6545	1334	651	4005	4525	8530
Curry, NM	CUR	5	5	5	2524	0	1384	2029	1879	3908
Dallam, TX	DAL	2	2	2	1156	0	0	709	447	1156
Dawson, TX	DAW	6	6	6	1263	641	1145	1649	1400	3049
Deaf Smith, TX	DEA	5	5	5	2189	0	2416	2563	2042	4605
Donley, TX	DON	1	1	1	0	0	1009	414	595	1009
Floyd, TX	FLO	17	17	17	10115	2042	2666	6985	7838	14823
Garza, TX	GAR	3	3	3	1840	399	0	1017	1189	2206
Gray, TX	GRA	8	8	8	962	1196	7476	5206	4428	9634
Hale, TX	HAL	14	14	15	7110	336	4127	6123	5450	11573
Hansford, TX	HAN	3	3	3	0	0	5055	2610	2445	5055
Hartley, TX	HAR	1	1	1	1511	0	0	683	828	1511
Hockley, TX	HOC	12	12	13	4640	468	0	2460	2648	5108
Howard, TX	HOW	2	2	2	775	0	490	654	611	1265
Hutchinson, TX	HUT	2	2	2	960	353	0	710	603	1313
Lamb, TX	LAM	12	12	12	4970	1219	912	3524	3577	7101
Las Animas, CO	LOS	3	4	4	3218	0	0	1454	1764	3218
Lea, NM	LEA	12	12	12	4408	206	369	2503	2480	4983
Lubbock, TX	LUB	9	9	10	3579	787	257	2267	2356	4623
Lynn, TX	LYN	8	8	9	3248	1048	785	2672	2409	5081
Moore, TX	MOO	2	2	2	2137	0	543	1398	1282	2680
Morton, KS	MOR	2	2	2	604	0	0	267	337	604
Ochiltree, TX	OCH	6	6	6	493	2403	2193	2438	2651	5089
Parmer, TX	PAR	5	5	5	1607	0	3175	2445	2337	4782
Quay, NM	QUA	2	2	2	539	517	0	539	517	1056
Randall, TX	RAN	6	6	6	3345	262	453	2060	2000	4060
Roosevelt, NM	ROOS	5	5	5	2334	154	511	1479	1520	2999
Sherman, TX	SHE	2	2	2	2114	764	0	1464	1414	2878
Swisher, TX	SWI	9	9	9	1473	957	5635	3886	4179	8065
Terry, TX	TER	5	5	6	2750	0	0	1257	1493	2750
Texas, OK	TEX	2	2	2	1220	334	0	804	750	155
TOTAL		227	228	233	105710	18022	48867	86297	86302	172599

Table 2. Average (SE) species richness, Shannon's diversity, and Simpson's diversity values for plant communities in playa wetlands with cropland and grassland watersheds and across all playas for seasonal (early vs. late) and overall sampling periods, among soil moisture categories[a], and among disturbance categories[b] for 224 playa wetlands in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas during 1995.

	Index		
	Species Richness	Simpson's Index	Shannon's Index
Watershed			
Cropland			
Early Season	13.1 (0.4)	0.66 (0.02)	1.49 (0.04)
Late Season	13.9 (0.4)	0.68 (0.01)	1.56 (0.04)
Overall	19.6 (0.5)	0.73 (0.01)	1.77 (0.04)
Grassland			
Early Season	12.8 (0.5)	0.63 (0.02)	1.43 (0.05)
Late Season	13.1 (0.5)	0.64 (0.02)	1.47 (0.05)
Overall	19.1 (0.6)	0.67 (0.02)	1.61 (0.04)
Combined			
Early Season	13.0 (0.3)	0.65 (0.01)	1.47 (0.05)
Late Season	13.6 (0.3)	0.67 (0.01)	1.52 (0.05)
Overall	19.4 (0.4)	0.71 (0.01)	1.70 (0.03)
Soil Moisture			
Dry	13.5 (0.3)	0.67 (0.01)	1.52 (0.03)
Moist	13.1 (0.6)	0.71 (0.01)	1.61 (0.05)
Flooded	12.8 (0.6)	0.61 (0.05)	1.37 (0.06)
Disturbance			
Low	19.5 (0.5)	0.70 (0.01)	1.69 (0.04)
Intermediate	18.8 (0.8)	0.73 (0.01)	1.75 (0.05)
High	19.4 (1.0)	0.68 (0.02)	1.64 (0.08)

[a]Soil moisture was qualitatively defined as: flooded - standing water over >50% of the playa floor; moist - standing water over <50% of the playa floor or sufficient topsoil moisture to form and maintain a soil ball; and dry - insufficient topsoil moisture to form a soil ball. [b]Disturbance was categorized based on changes in soil moisture from the early to late season and classified as high (soil moisture change from dry to flooded or flooded to dry), intermediate (slight soil moisture change such as moist to flooded, dry to moist, flooded to moist, or moist to dry), and low (no change in soil moisture among seasons).

greatest in playas with moist soil, followed by dry soil, and then flooded soil.

Disturbance - Of the 224 twice-surveyed playas, 36, 43, and 145 experienced high, intermediate, and low disturbance effects between early and late season surveys, respectively. Proportion of playas within each disturbance category was not different between cropland and grassland playas ($\chi^2_3 = 3.43$, $P = 0.18$). Playa area was similar among disturbance categories ($F_{2,221} = 0.24$, $P = 0.78$; high = 13.4 ha, SE = 1.3; intermediate = 15.0 ha, SE = 2.3; low = 15.4 ha, SE = 1.4). Species richness did not differ among disturbance categories ($F_{2,216} = 1.61$, $P = 0.20$; Table 2). However, Shannon's diversity was higher for intermediate disturbance compared to high disturbance but did not differ from the value for low disturbance ($F_{2,216} = 2.84$, $P = 0.06$; Table 2). There was more variation in species richness and diversity between land uses for playas experiencing relatively high and low disturbance compared to those with intermediate disturbance (Figure 2).

Ordination - For interpretation purposes at the playa scale, we are presenting results from the correspondence analyses of common species (i.e., >5% frequency). Plots of correspondence scores including all species and each playa were not possible at a scale allowing for distinction among species and playas along any dimension. Plots of common species allow for identification of those species contributing to the variation in species among playas. Species occurring farthest from the origin are those that have the most influence in separating playas. Those species closest to the origin contribute little to the separation of playas, identifying species that are distributed among all playas within the PLR. Essentially, these analyses indicated that those species limited either spatially or temporally in playas contributed most to the separation of plant communities among playas compared to those species that were wide-spread in the PLR.

Across all playas, examining all species on a seasonal basis, the first three dimensions accounted for 13.1% of the total variation, with 57 dimensions needed to account for 90% of variation. Examining only common species (>5% frequency) on a seasonal basis, the first three dimensions accounted for 14.8% of the total variation, with 38 dimensions needed to account for 90% of variation. It took 28 dimensions to account for 90% of the variation in correspondence analyses and the first three dimensions accounted for 20% of the total variation in the overall analyses of common species. Across watershed types, species positions on the first three dimensions were different between the seasonal data and the overall data (Figures 3 and 4), indicating that relationships among species change depending on the temporal scale being examined. However, with the exception of *Sorghum halepense* in the overall analyses, species contributing to the separation of playas were similar for both analyses.

In the seasonal analyses, species contributing to playa separation along the first dimension were *Ambrosia psilostachya*, *Opuntia phaeacantha*, *Ratibida columnifera*, *Melilotus officinalis*, *Agropyron smithii*, *Ratibida tagetes*, *Sitanion hystrix*, *Buchloë dactyloides*, *Quincula lobata*, *Suckleya suckleyana*, *Polygonum lapathifolium*, *Typha domingensis*, *Scirpus validus*, *Heteranthera limosa*, *Malvella leprosa*, *Sagittaria longiloba*, and *Cyperus esculentus* (Figure 3). Along the second dimension, the separating species were *Suckleya suckleyana*, *Ambrosia psilostachya*, *Opuntia phaeacantha*, *Verbena bracteata*, *Xanthium strumarium*, *Heteranthera limosa*, *Malvella leprosa*, *Sagittaria longiloba*, and *Leptochloa fascicularis*. Along the third dimension, the separating species were *Ambrosia psilostachya*, *Sorghum halepense*, *Melilotus officinalis*, *Agropyron smithii*, *Schedonnardrus paniculatus*, *Lythrum californicum*, *Sitanion hystrix*, *Lippia nodiflora*, *Opuntia phaeacantha*, and *Ratibida columnifera* (Figure 3).

In the overall analyses, species contributing to playa separation along the first dimension were *Ratibida columnifera*, *Opuntia phaeacantha*, *Ambrosia psilostachya*, *Melilotus officinalis*, *Agropyron smithii*, *Lythrum californicum*, *Schedonnardrus paniculatus*, *Sitanion hystrix*, *Lippia nodiflora*, *Ratibida tagetes*, *Typha domingensis*, *Scirpus validus*, *Polygonum lapathifolium*, and *Suckleya suckleyana* (Figure 4). Along the second dimension, the separating species were *Sorghum halepense*, *Suckleya suckleyana*, *Bromus unioloides*, *Quincula lobata*, *Heteranthera limosa*, *Sagittaria longiloba*, *Malvella leprosa*, *Lythrum californicum*, and *Agropyron smithii*. Along the third dimension, the contributing species were *Typha domingensis*, *Scirpus validus*, *Polygonum*

lapathifolium, *Conyza canadensis*, and *Helenium microcephalum* (Figure 4).

In the overall analyses of cropland playas, it took 28 dimensions to account for 90% of the variation in correspondence analyses and the first three dimensions accounted for 19.3% of the total variation. The first three dimensions of the grassland playa analysis accounted for 26% of the total variation, with 24 dimensions needed to account for 90% of the variation.

Species separating playas with grassland watershed along the first dimension of correspondence analysis were *Suckleya suckleyana*, *Kochia scoparia*, *Sagittaria longiloba*, *Ambrosia psilostachya*, *Quincula lobata*, *Ratibida tagetes*, *Prionopsis ciliata*, *Sorghum halepense*, *Polygonum pensylvanicum*, and *Scirpus validus* (Figure 5). Species along the second dimension contributing to separation of grassland playas were *Suckleya suckleyana*, *Kochia scoparia*, *Ratibida columnifera*, *Lactuca serriola*, *Hoffmanseggia glauca*, *Sagittaria longiloba*, *Sorghum halepense*, *Polygonum amphibium*, *Sitanion hystrix*, *Malvella leprosa*, and *Cyperus esculentus*. Along the third dimension, the contributing species were *Hoffmanseggia glauca*, *Verbena bracteata*, *Suckleya suckleyana*, *Xanthium strumarium*, *Sagittaria longiloba*, *Malvella leprosa*, and *Nothoscordum bivalve* (Figure 5).

Compared to the grassland playa correspondence analyses, common species in playas with cropland watersheds spread further along the first three dimensions (Figure 6). Species along the first dimension contributing to separation of cropland playas were *Agropyron smithii*, *Heteranthera limosa*, *Nothoscordum bivalve*, *Schedonnardrus paniculatus*, *Portulaca oleracea*, *Solanum rostratum*, *Lippia nodiflora*, *Sorghum halepense*, *Tragopogon dubius*, *Bromus unioloides*, *Solanum elaeagnifolium*, *Sitanion hystrix*, and *Quincula lobata*. Along the second dimension, species contributing to the separation of cropland playas include *Typha domingensis*, *Scirpus validus*, *Polygonum lapathifolium*, *Sitanion hystrix*, *Ratibida columnifera*, *Kochia scoparia*, *Suckleya suckleyana*, *Helenium microcephalum*, and *Helianthus ciliaris*. Along the third dimension, the contributing species were *Sorghum halepense*, *Tragopogon dubius*, *Bromus unioloides*, *Scirpus validus*, *Agropyron smithii*, *Sitanion hystrix*, *Kochia scoparia*, *Ratibida columnifera*, *Typha domingensis*, and *Scirpus validus* (Figure 6).

At the county scale, for all species across sampling periods, the first three components of correspondence analyses accounted for 28.7% of the variation with 90% of the variation accounted for in the first 21 dimensions. For common species across sampling periods, the first three dimensions of correspondence analyses accounted for 33% of the variation with 90% of the variation accounted for in the first 18 dimensions.

Species contributing to separation of counties along the first dimension included *Melilotus officinalis*, *Sisymbrium altissimum*, *Lactuca serriola*, *Agropyron smithii*, *Schedonnardrus paniculatus*, *Ratibida columnifera*, *Opuntia phaeacantha*, *Sitanion hystrix*, *Lippia nodiflora*, *Tragopogon dubius*, *Ambrosia psilostachya*, *Cuscuta squamata*, *Sorghum halepense*, *Helenium microcephalum*, and *Polygonum amphibium*. Along the second dimension, species contributing to the separation of counties included *Ratibida tagetes*, *Panicum obtusum*, *Hoffmanseggia glauca*, *Haplopappus ciliatus*, *Solanum elaeagnifolium*, *Quincula lobata*, *Bromus unioloides*, *Sorghum halepense*, *Helenium microcephalum*, *Polygonum lapathifolium*, *Sagittaria longiloba*, *Malvella leprosa*, and *Heteranthera limosa* (Figure 7). Along the third dimension, species contributing to the separation of counties included *Ratibida tagetes*, *Hoffmanseggia glauca*, *Scirpus validus*, *Sorghum halepense*, *Helenium microcephalum*, *Sitanion hystrix*, *Phalaris caroliniana*, *Polygonum amphibium*, *Malvella leprosa*, *Heteranthera limosa*, and *Quincula lobata* (Figure 7).

Based on correspondence scores, counties of the PLR were grouped geographically. The first dimension represented a south to north or length-of-growing-season gradient (Figure 8). The second dimension depicted a west to east or precipitation gradient. There was relatively little separation along the third dimension (Figure 8).

Six county groupings were identified based on ordination scores of extant plant communities (Figure 9). Considerable variation was found in species occurrence and community composition among ordination groups (Appendix IV). Playa area did differ among

(text continued on page 32)

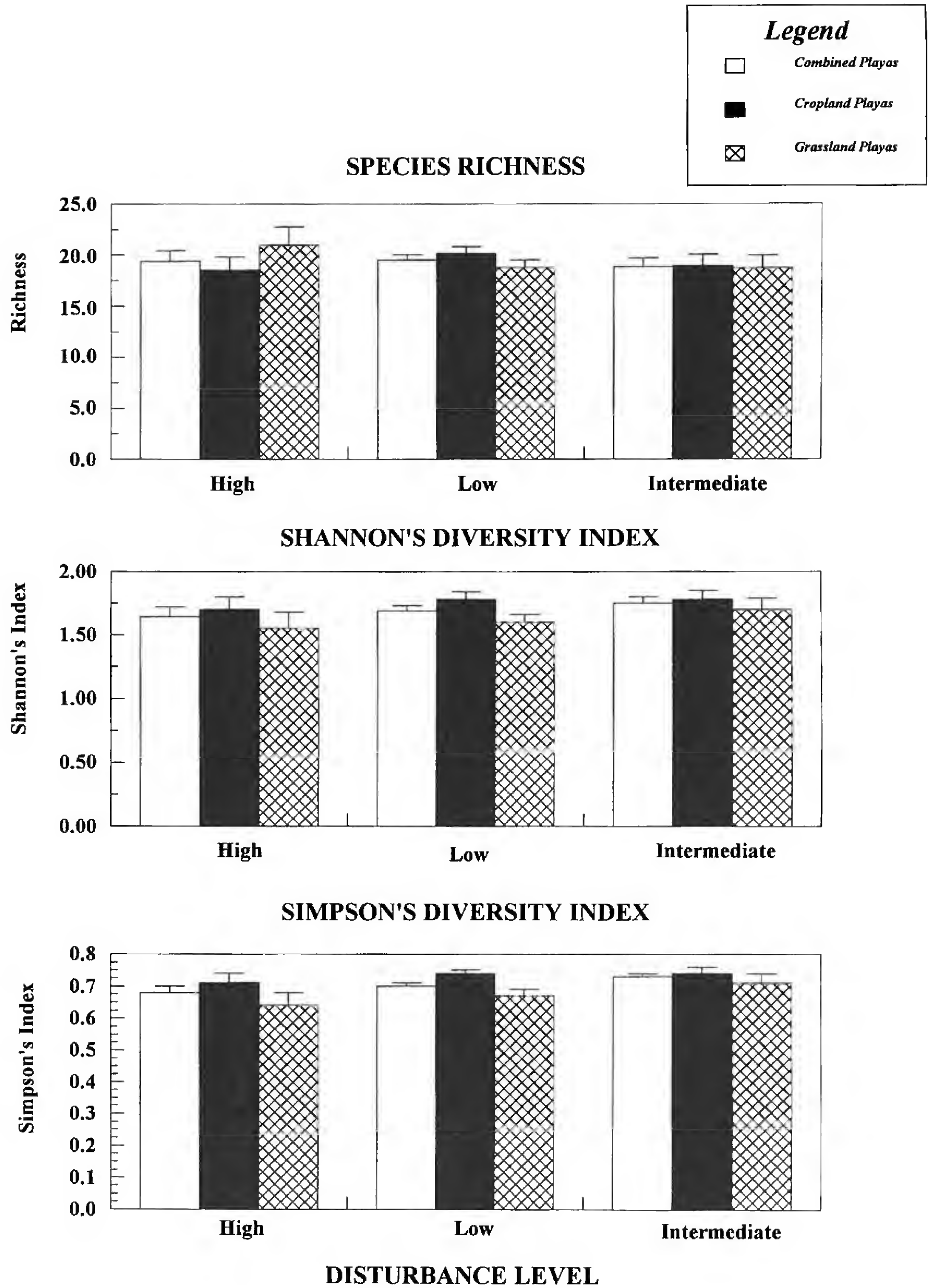

Figure 2. Species richness, Shannon diversity values, and Simpson diversity levels in relation to playa disturbance level for plant species found in all sampled 224 playas and those separated by watershed type (cropland or grassland) in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995.

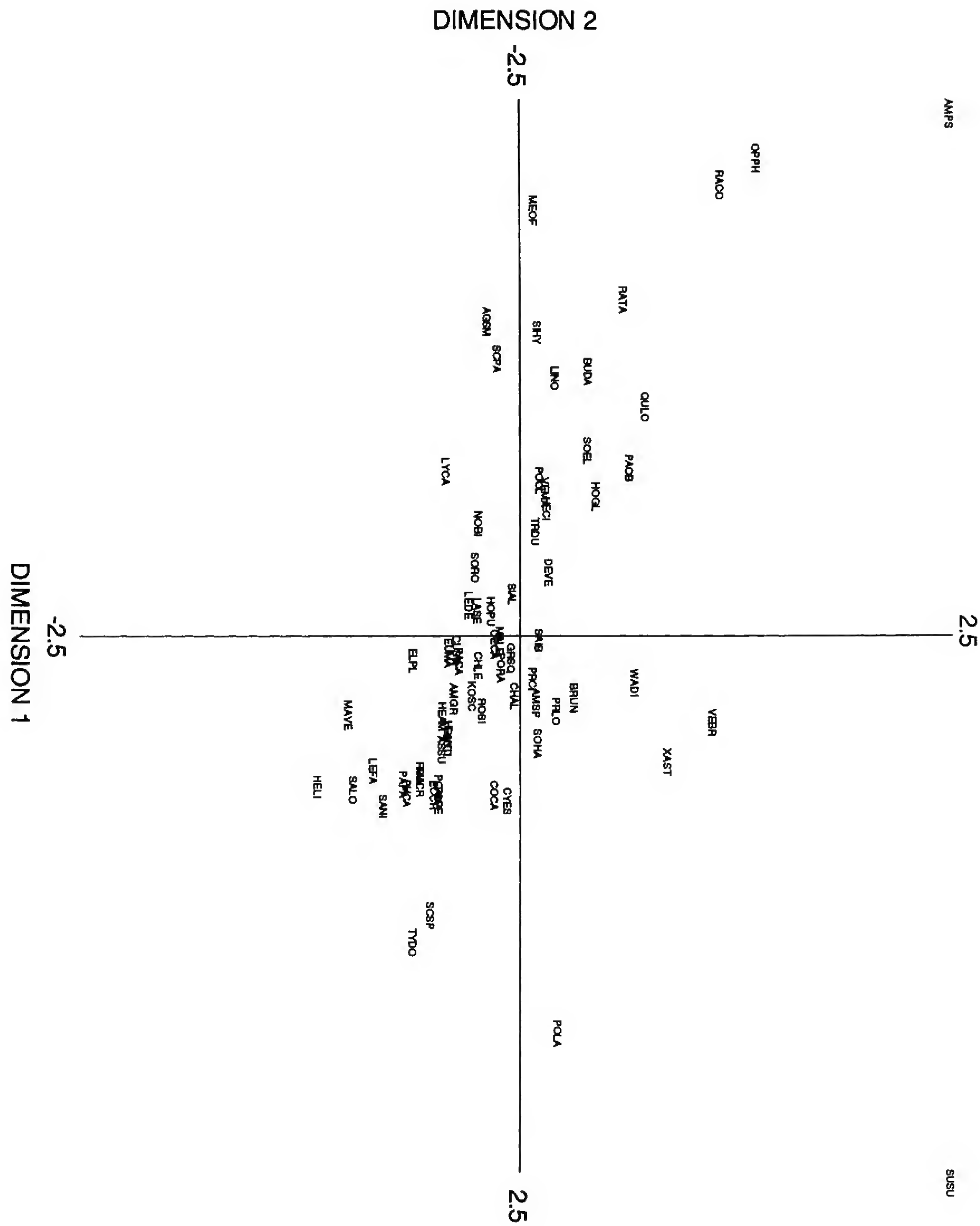

Figure 3. Position of scores for common species (>5% frequency) separated by seasonal sampling (early and late) along the first three dimensions produced by correspondence analysis of plant communities in 224 playas in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995. Species codes are defined in Appendix I.

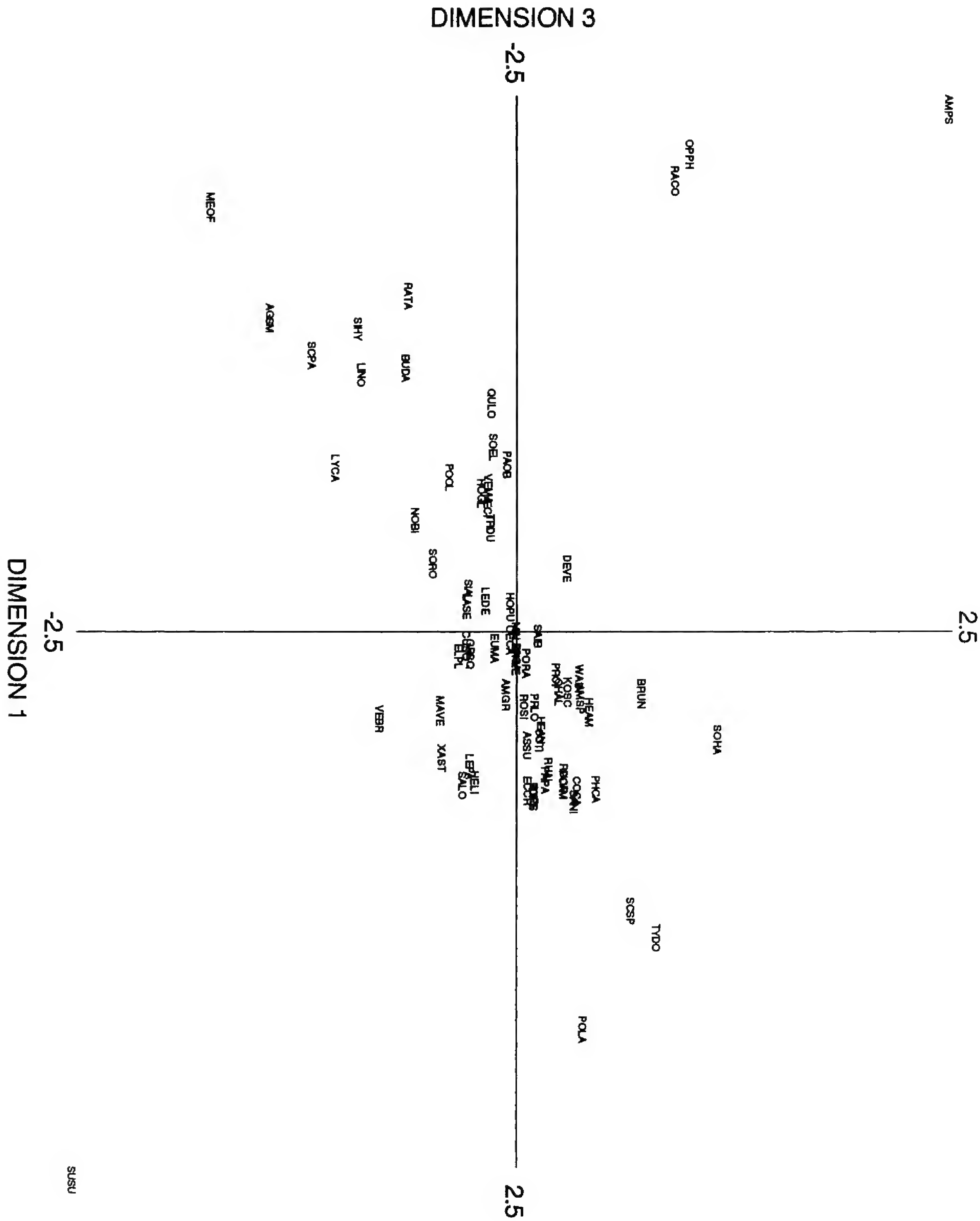

Figure 3. (cont.)

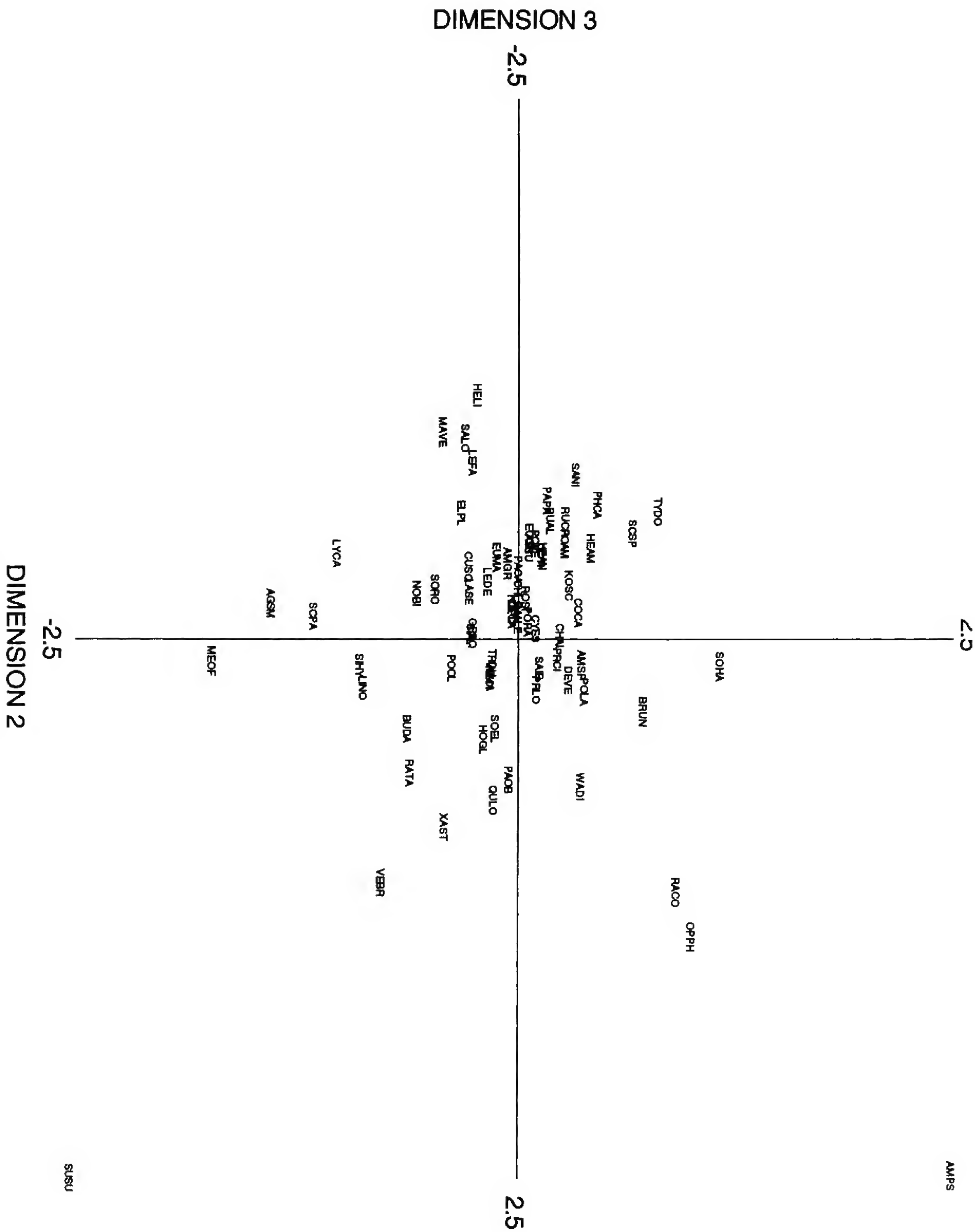

Figure 3. (cont.)

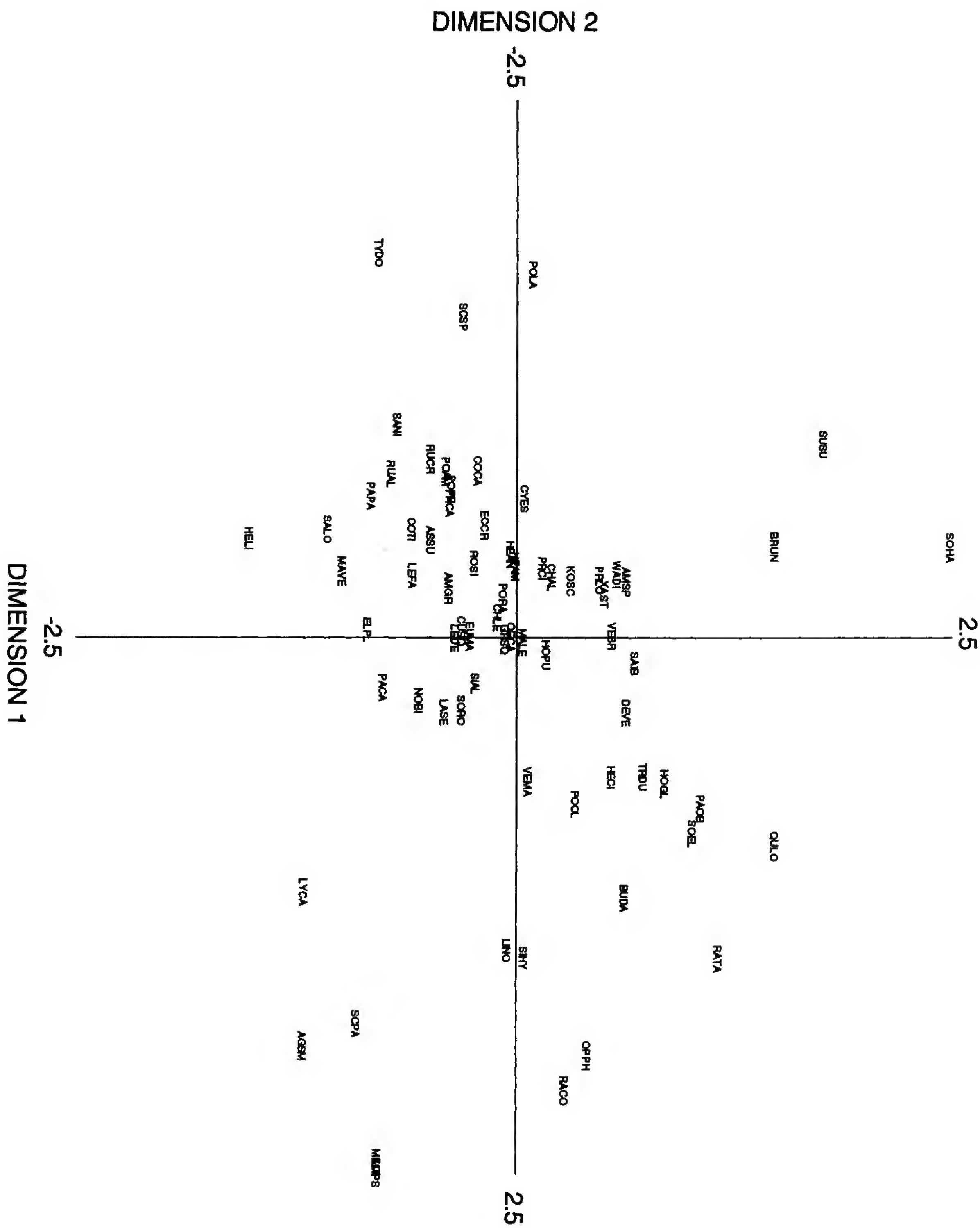

Figure 4. Position of scores for common species (>5% frequency) across the growing season along the first three dimensions produced by correspondence analysis of plant communities in 224 playas in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995. Species codes are defined in Appendix I.

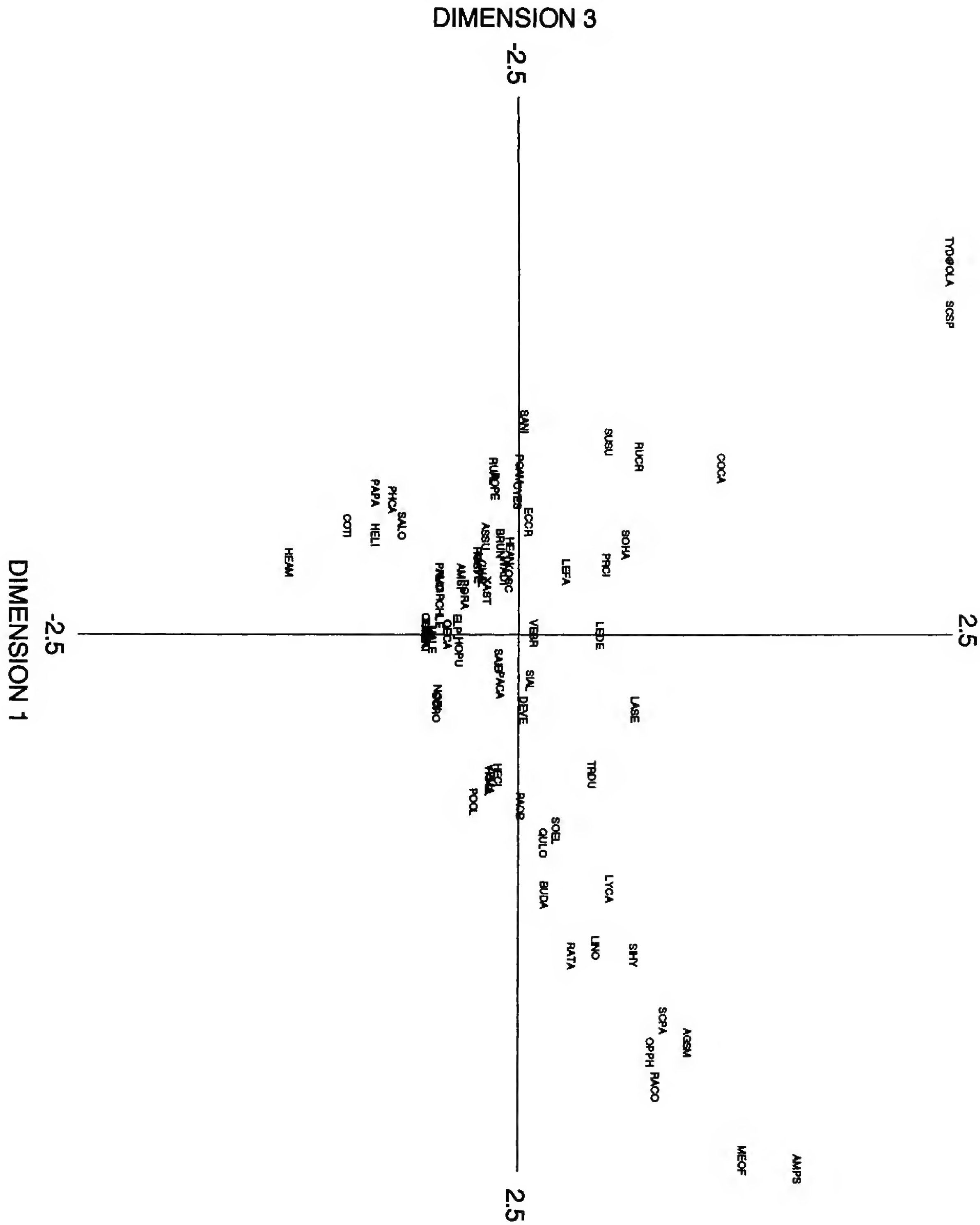

Figure 4. (cont.)

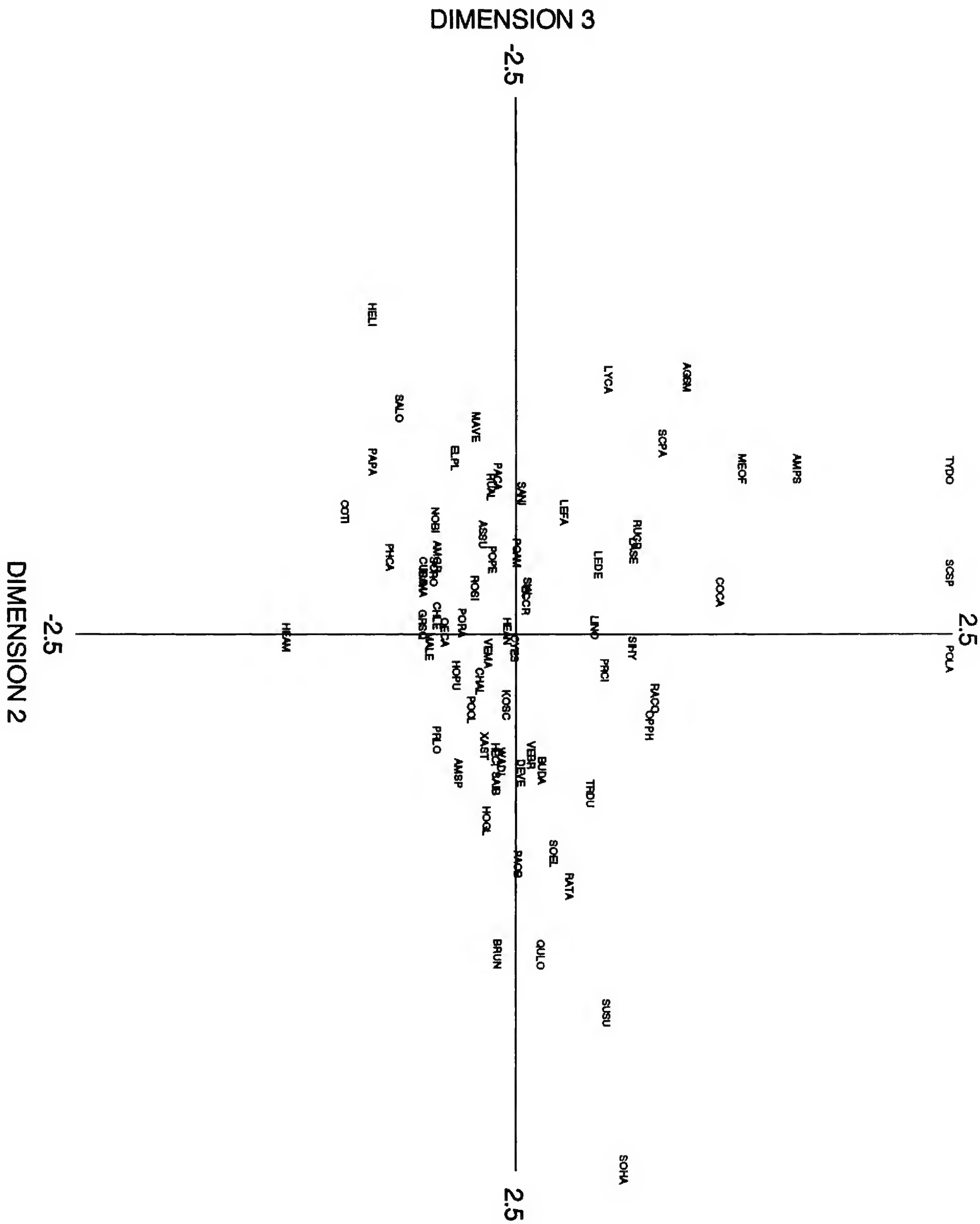

Figure 4. (cont.)

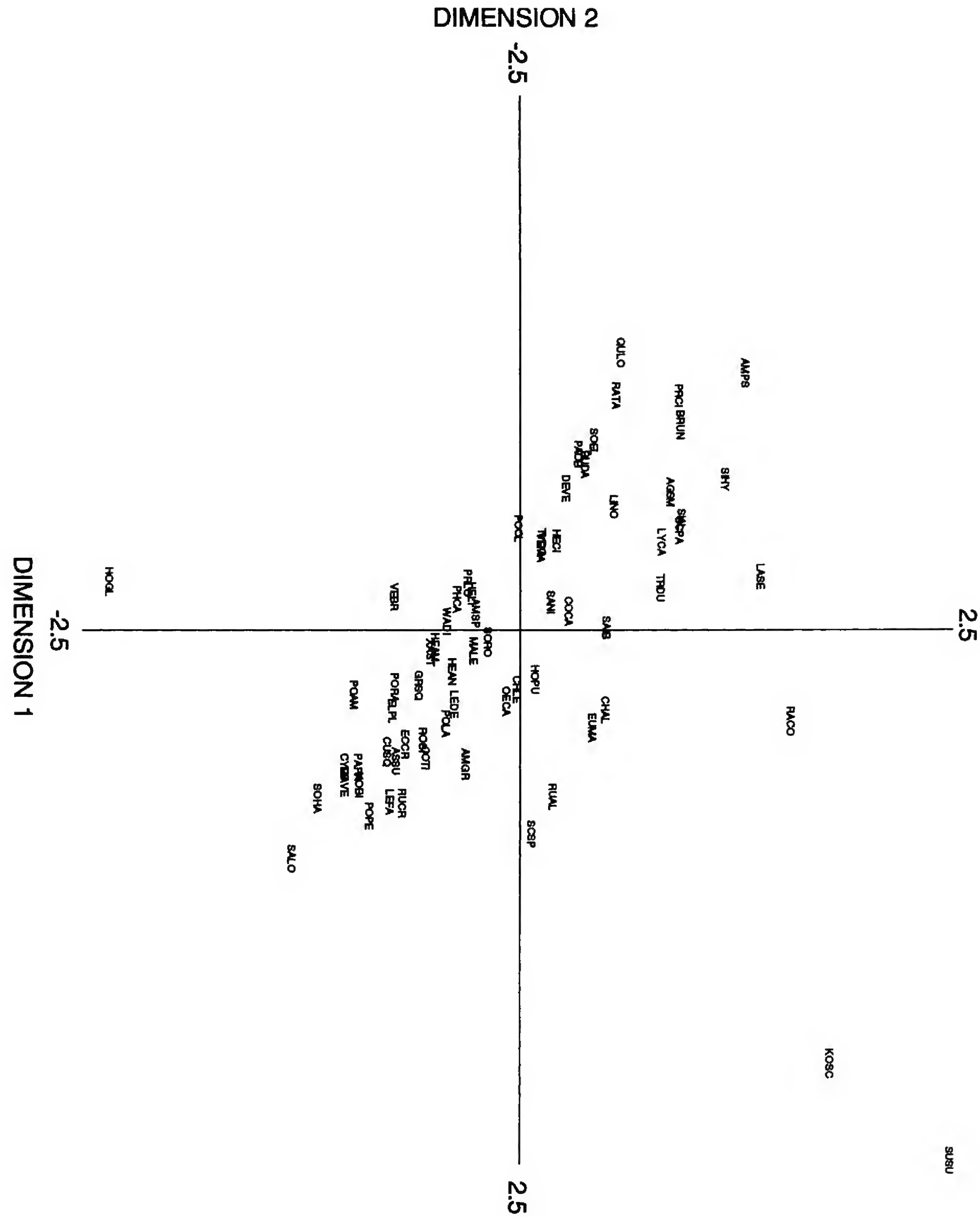

Figure 5. Position of scores for common species (>5% frequency) along the first three dimensions produced by correspondence analysis of plant communities in 98 playas with grassland watersheds in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995. Species codes are defined in Appendix I.

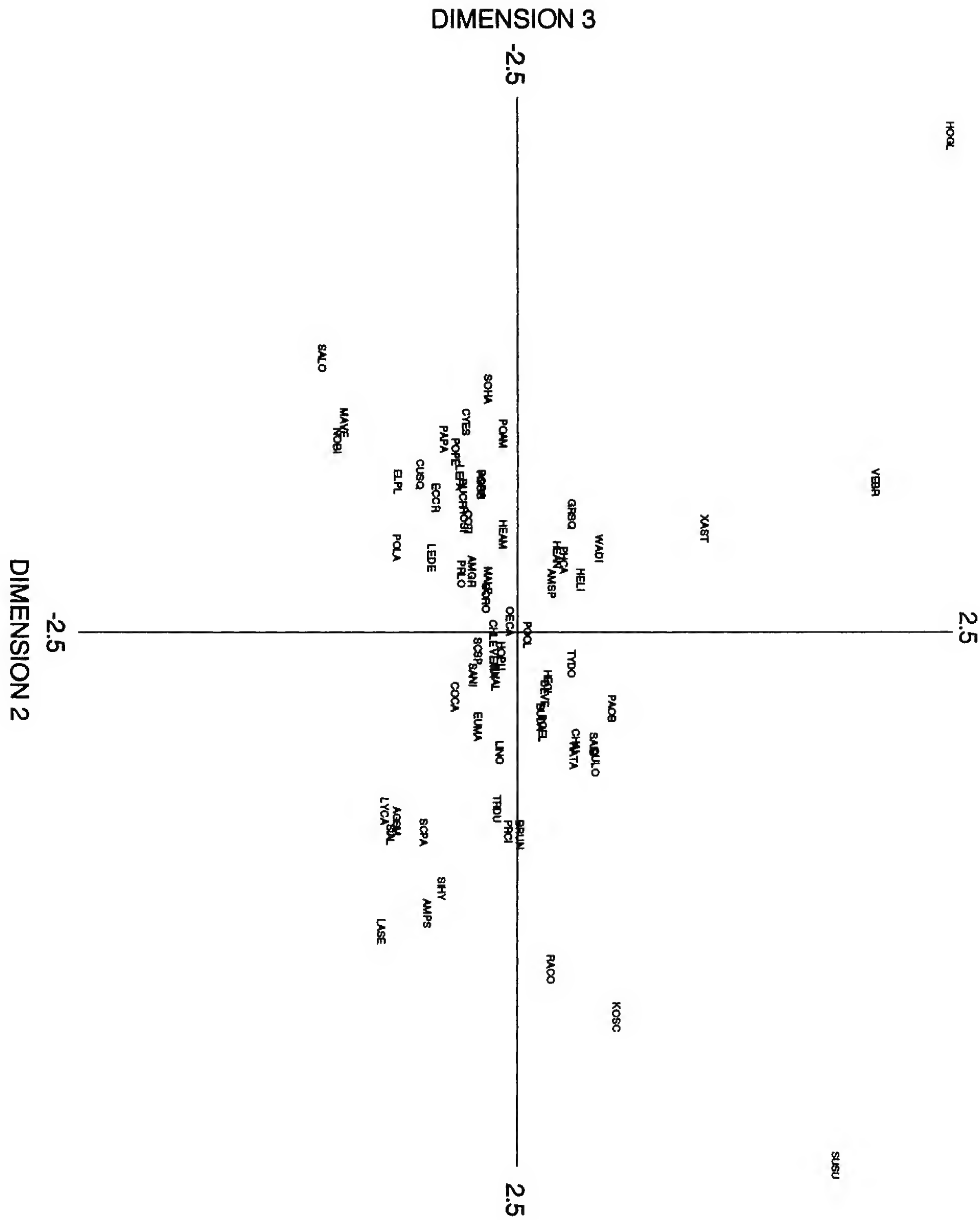

Figure 5. (cont.)

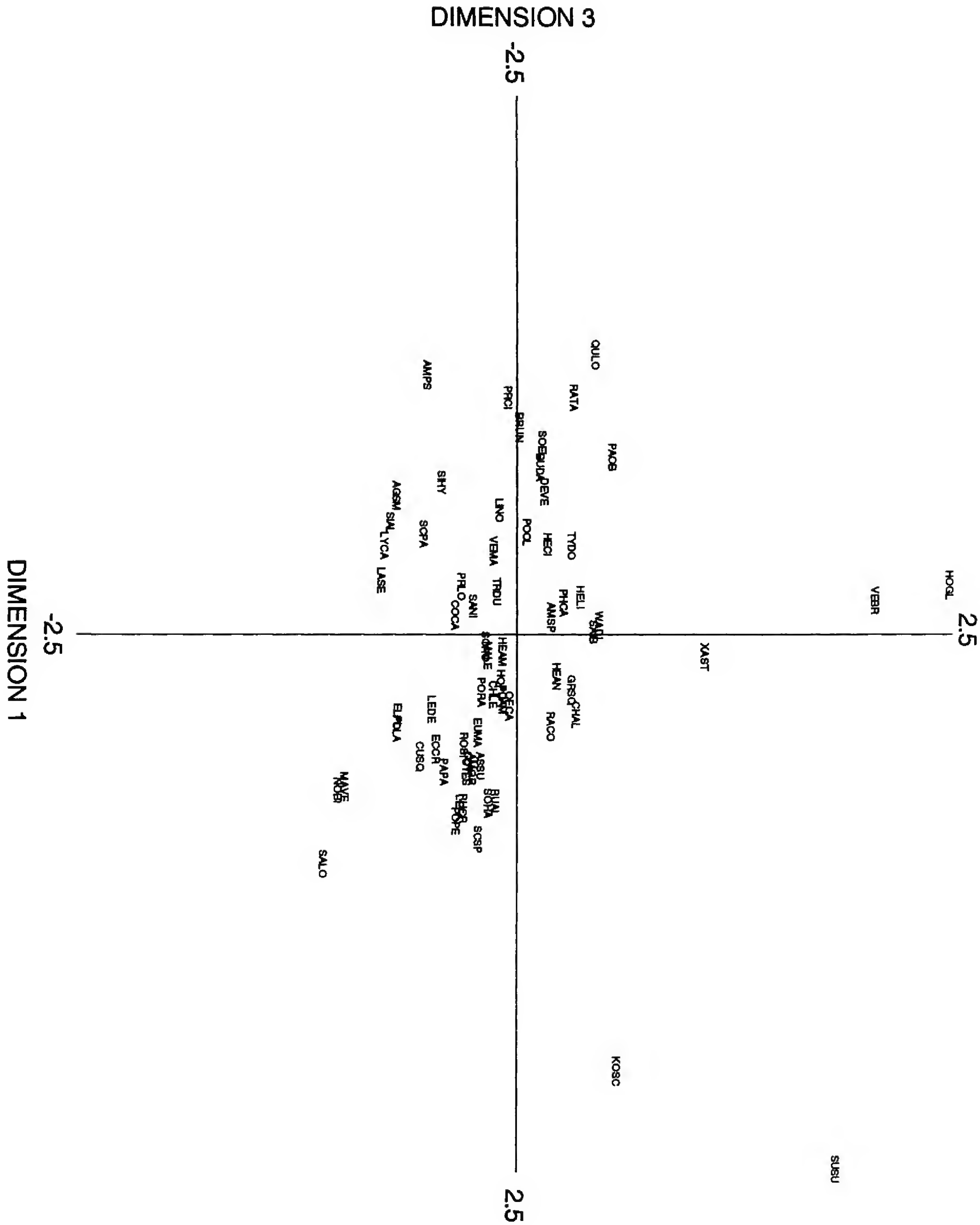

Figure 5. (cont.)

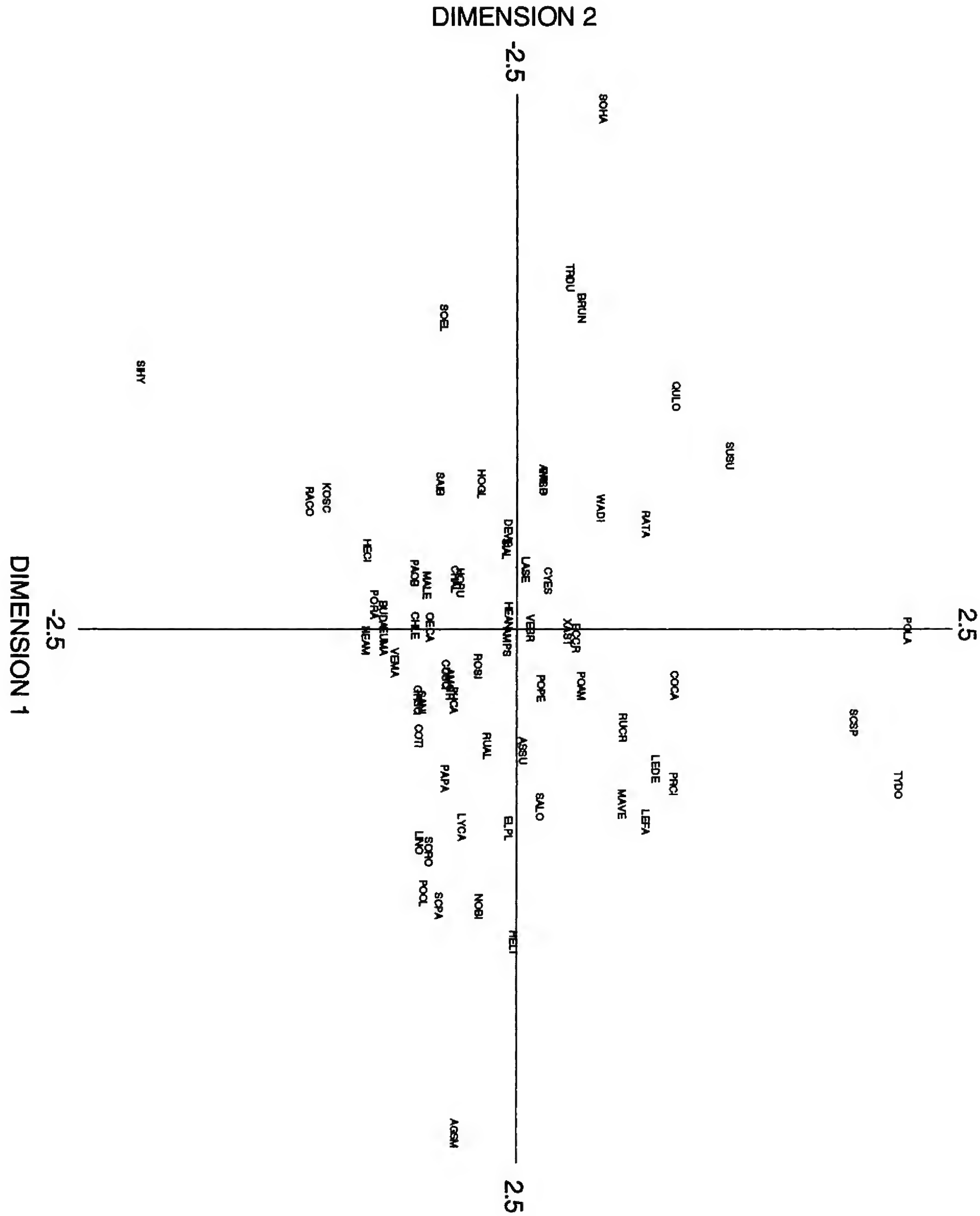

Figure 6. Position of scores for common species (>5% frequency) along the first three dimensions produced by correspondence analysis of plant communities in 126 playas with cropland watersheds in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995. Species codes are defined in Appendix I.

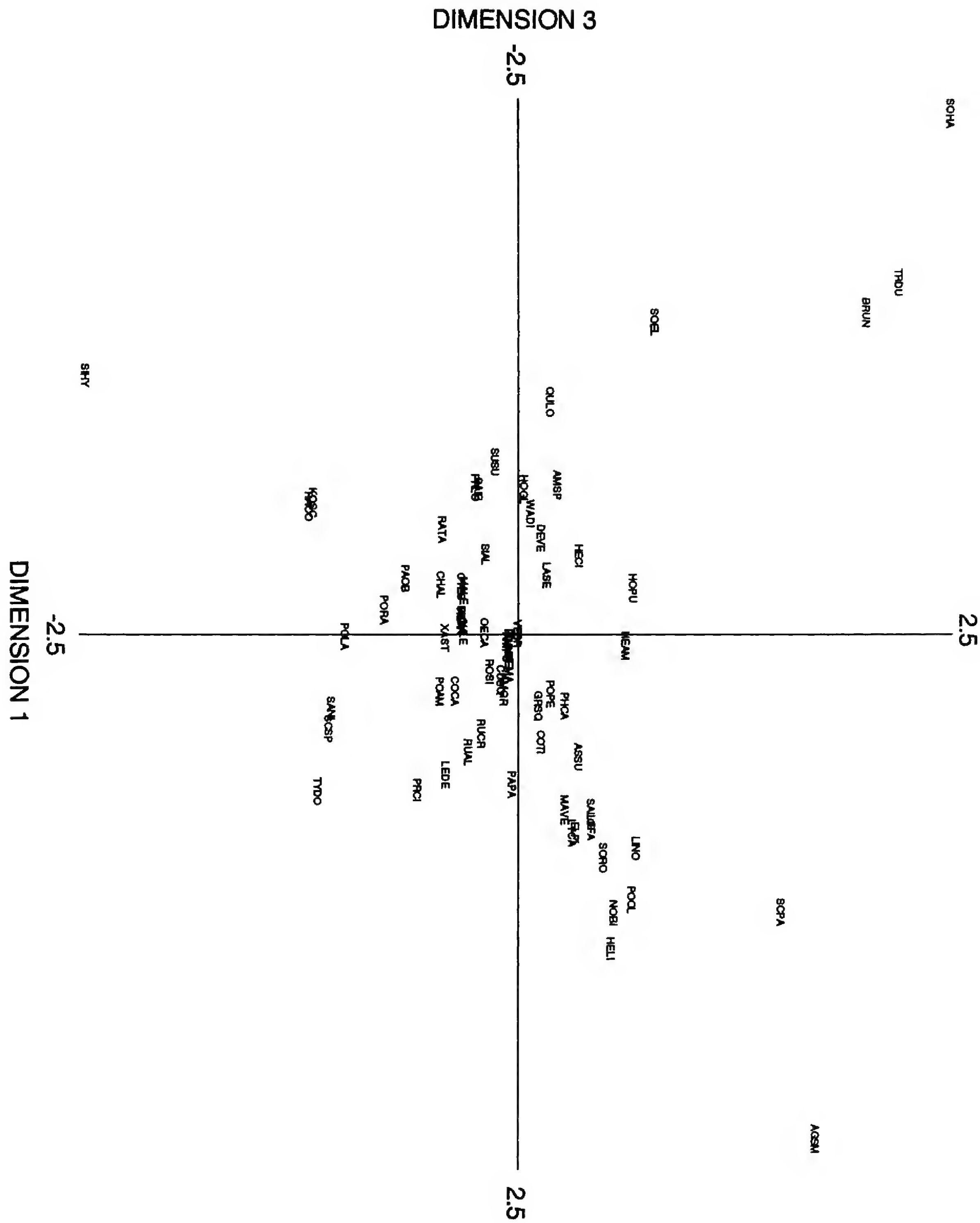

Figure 6. (cont.)

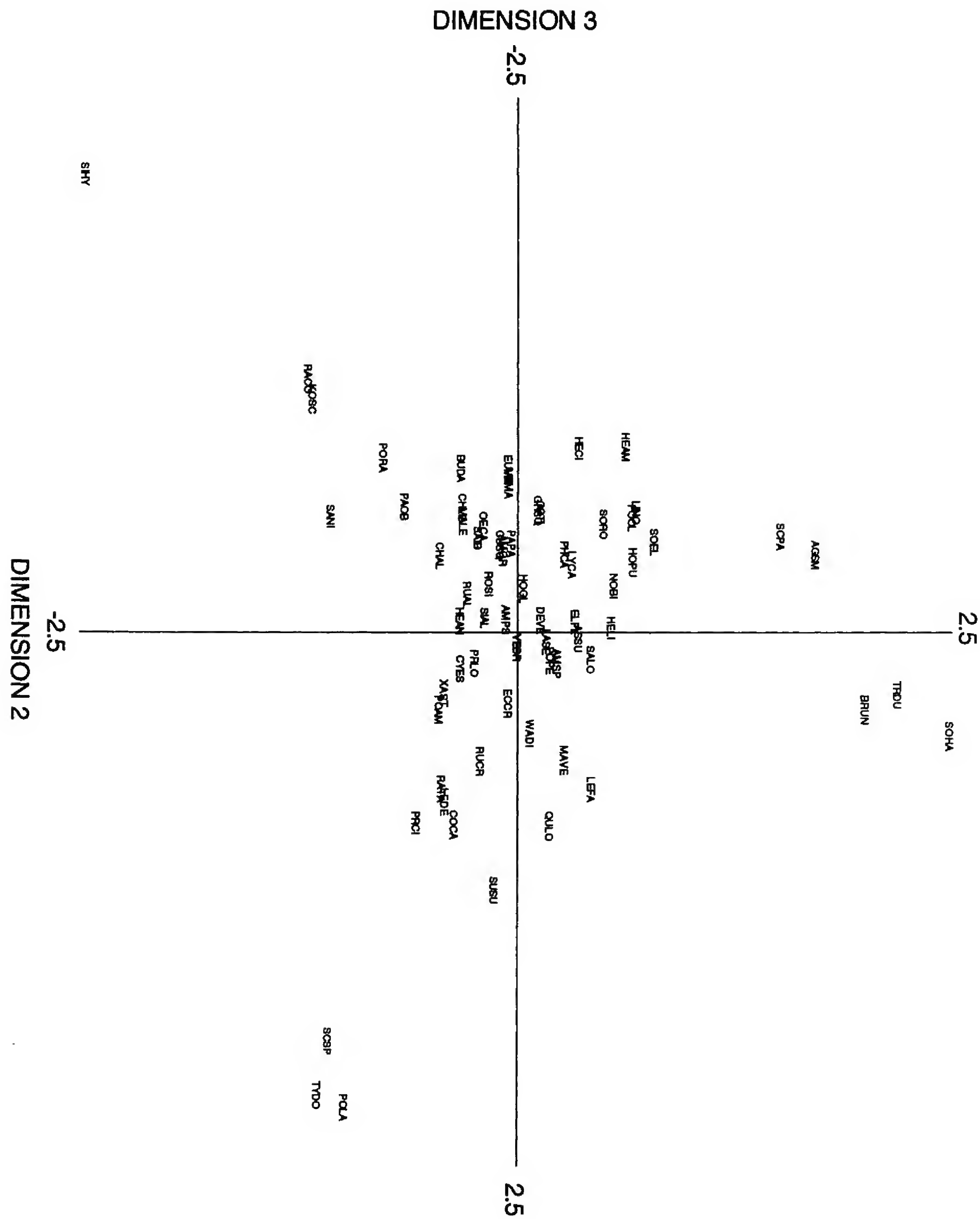

Figure 6. (cont.)

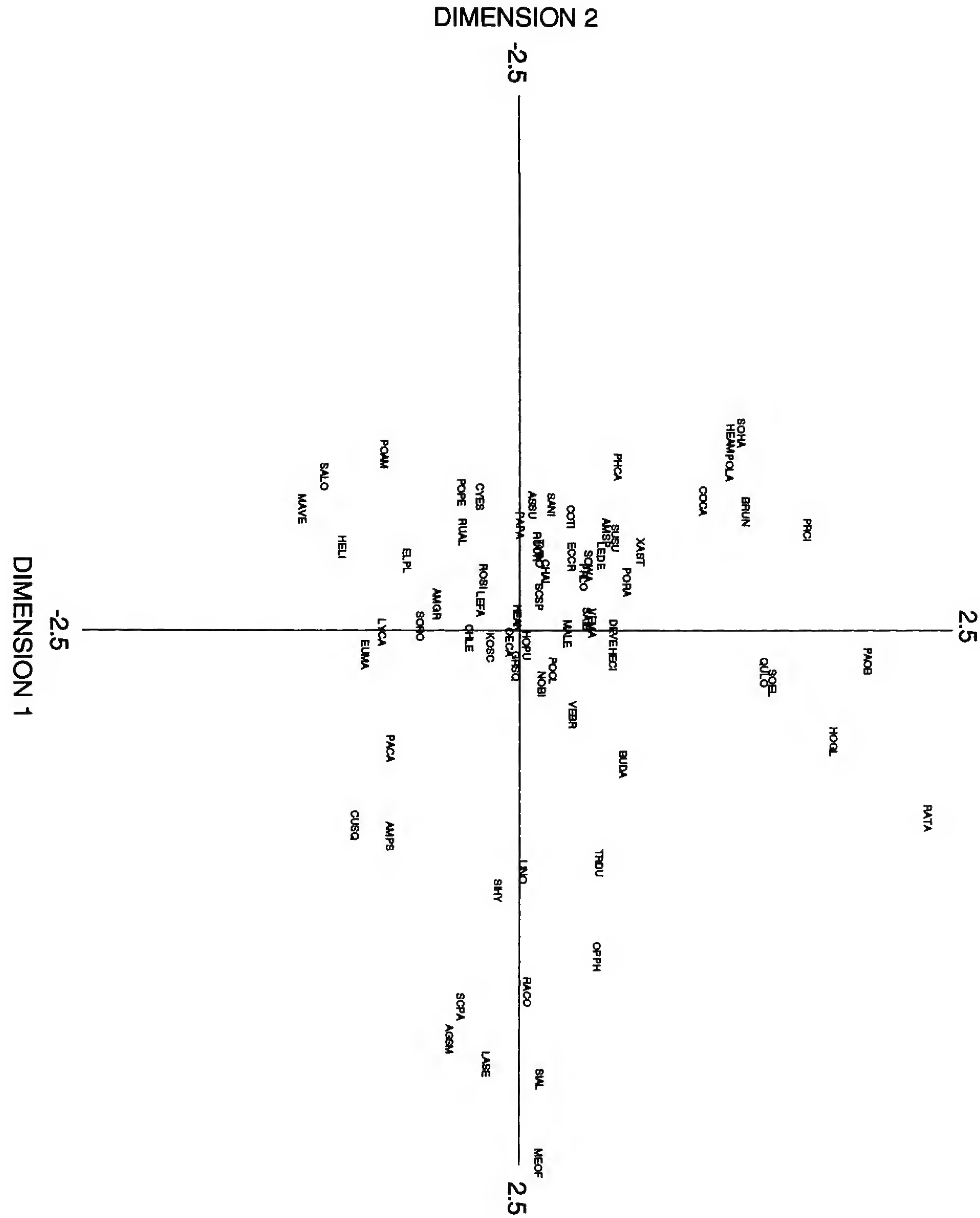

Figure 7. Position of scores for common species (>5% frequency) along the first three dimensions produced by correspondence analysis of plant communities at the county scale including 224 playas in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995. Species codes are defined in Appendix I.

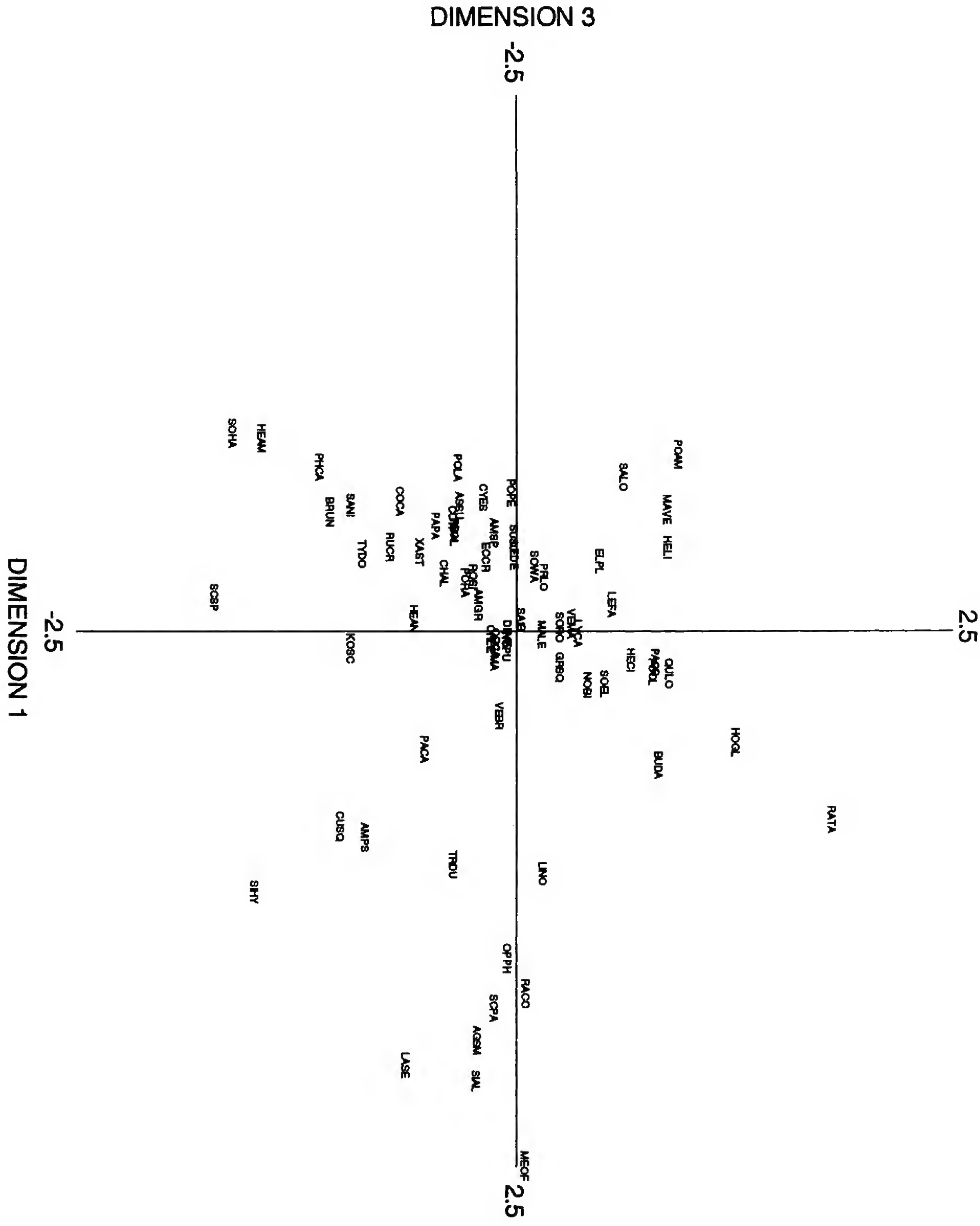

Figure 7. (cont.)

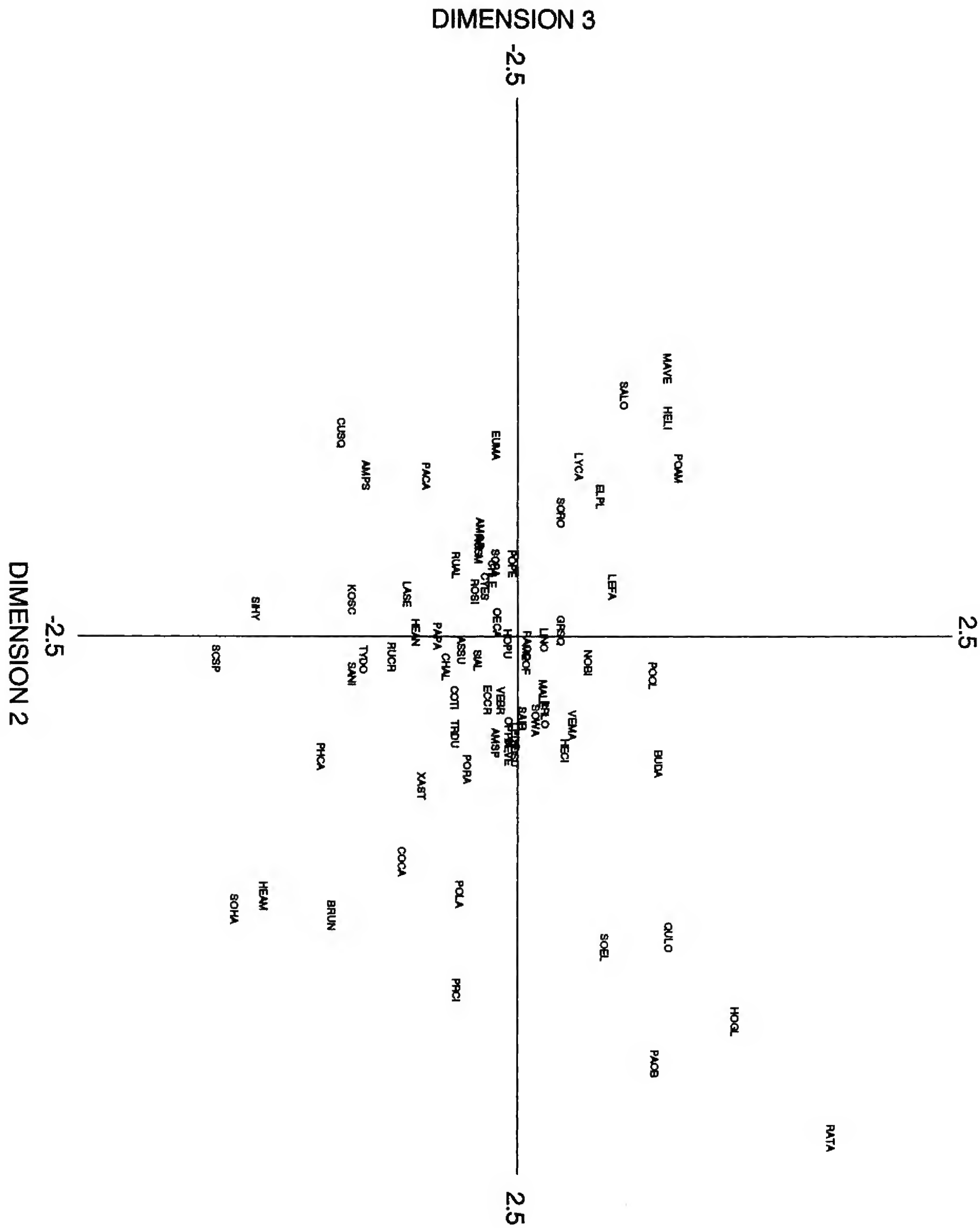

Figure 7. (cont.)

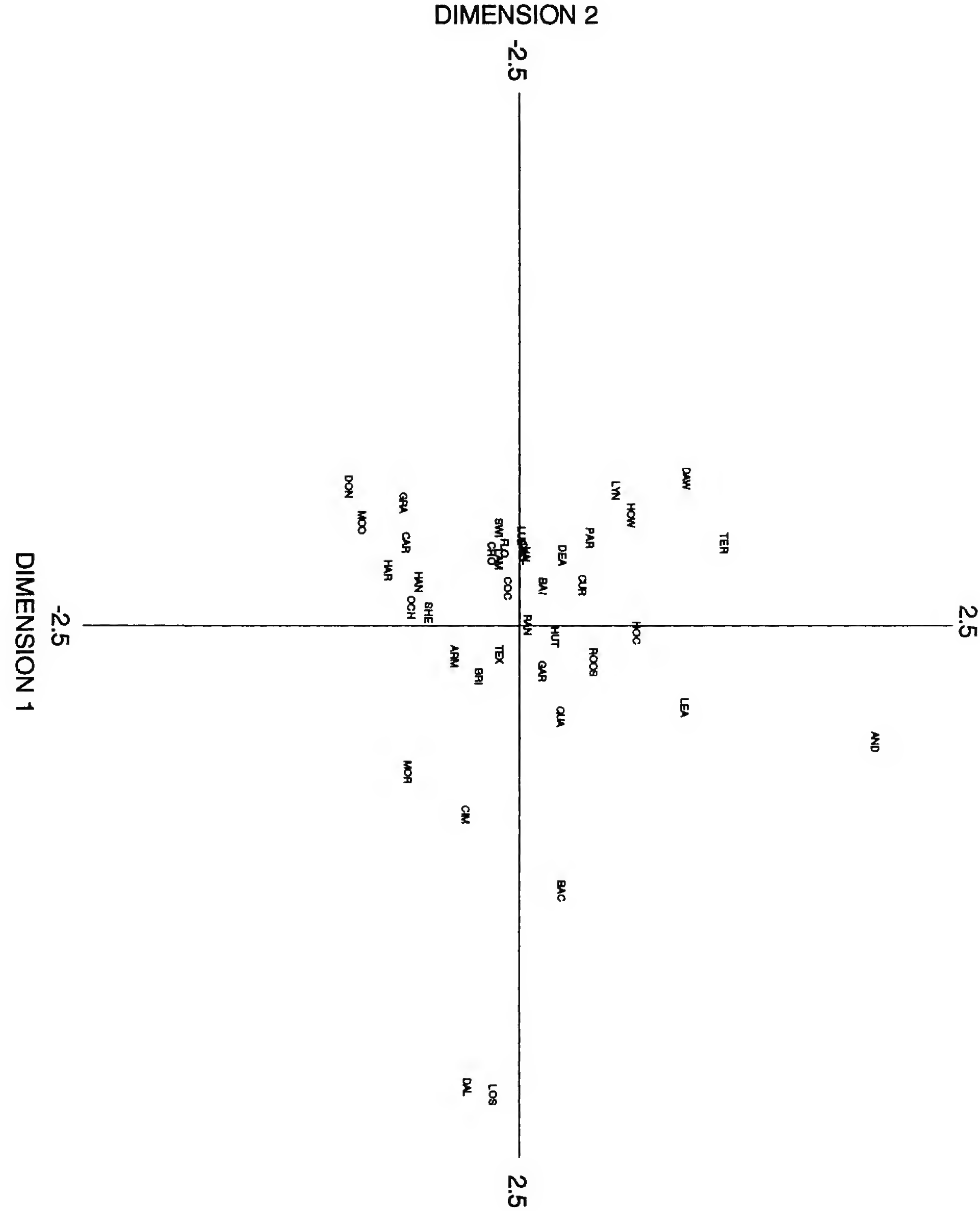

Figure 8. Position of scores for counties along the first three dimensions produced by correspondence analysis of plant communities at the county scale including 224 playas in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995. County codes are defined in Table 1.

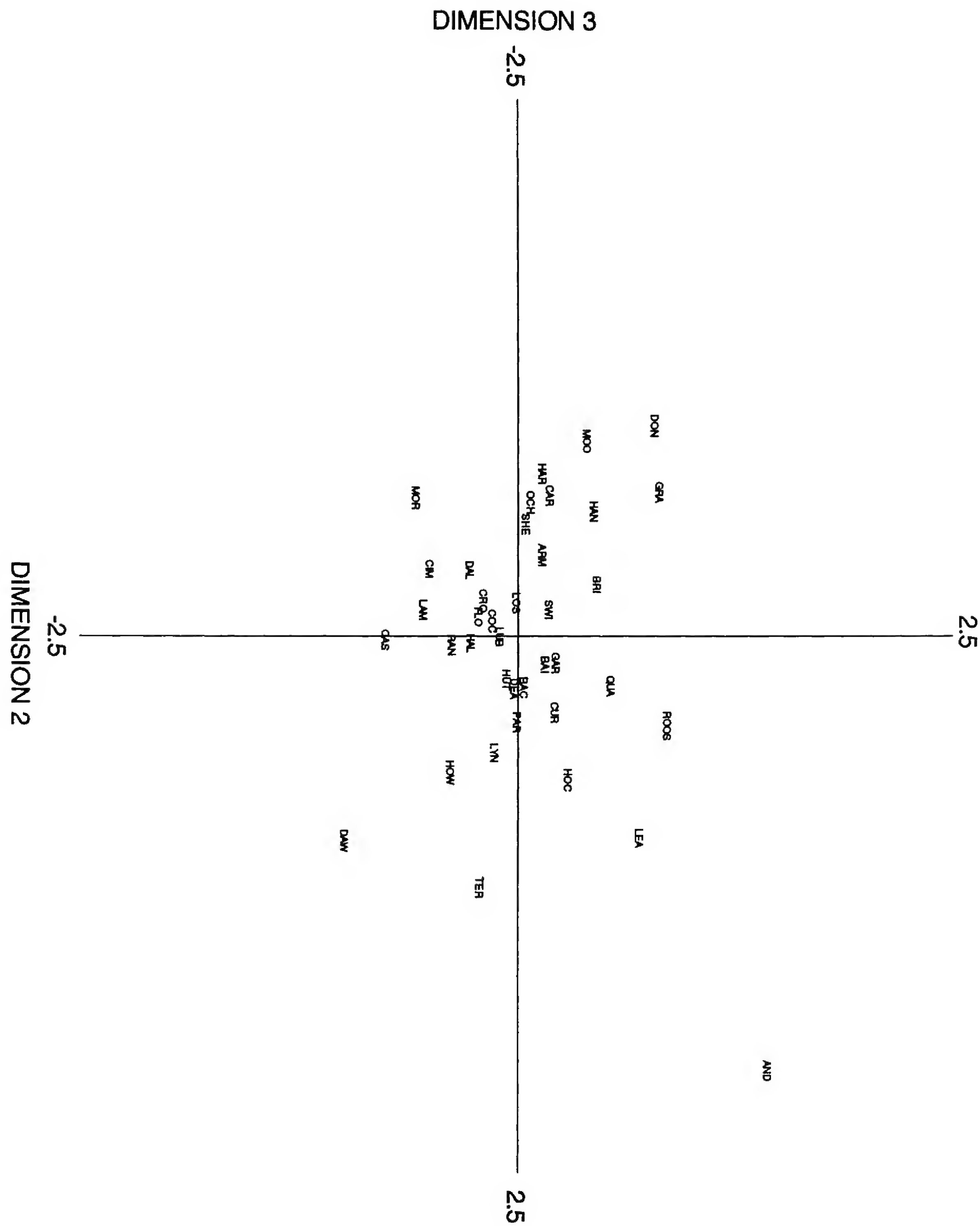

Figure 8. (cont.)

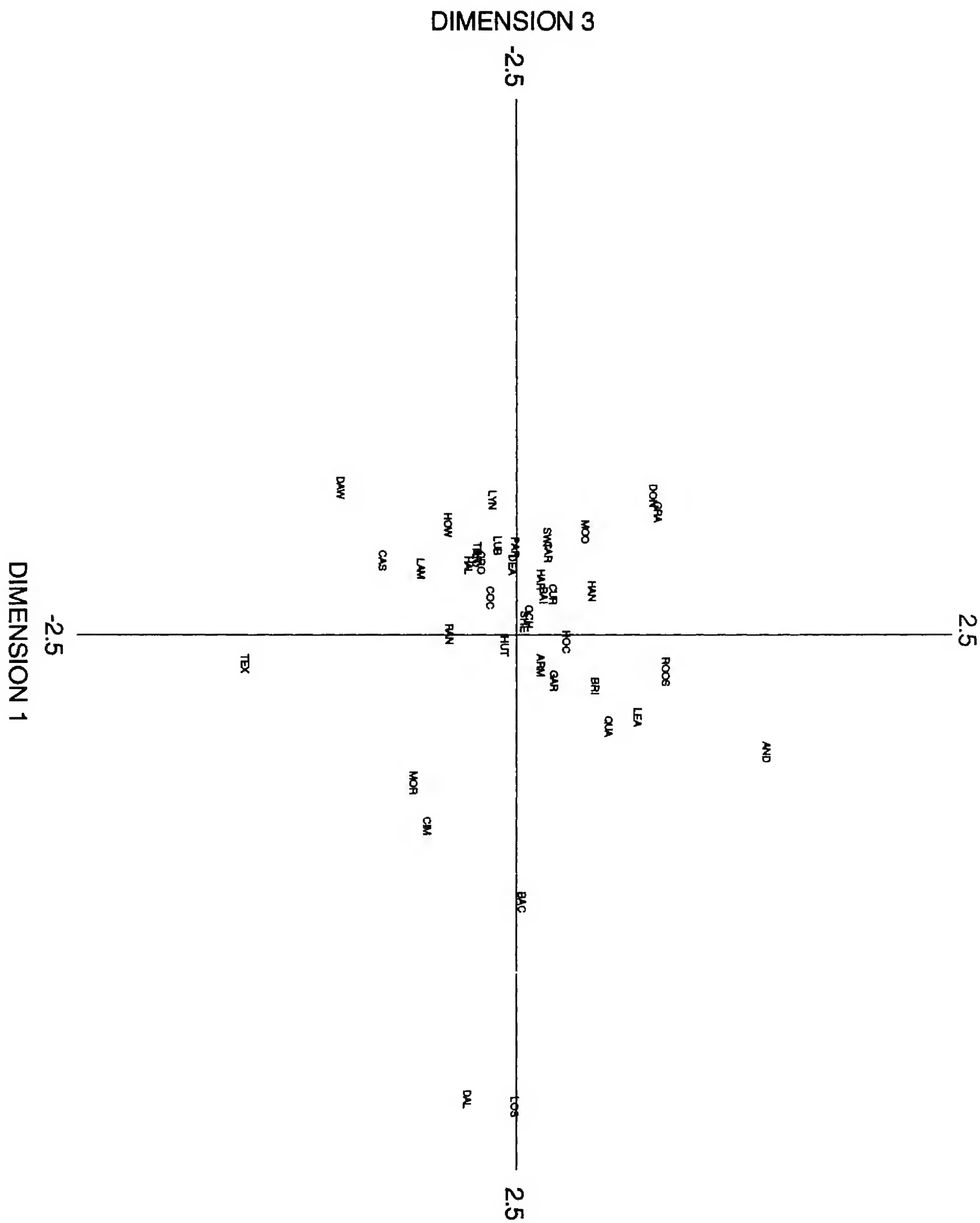

Figure 8. (cont.)

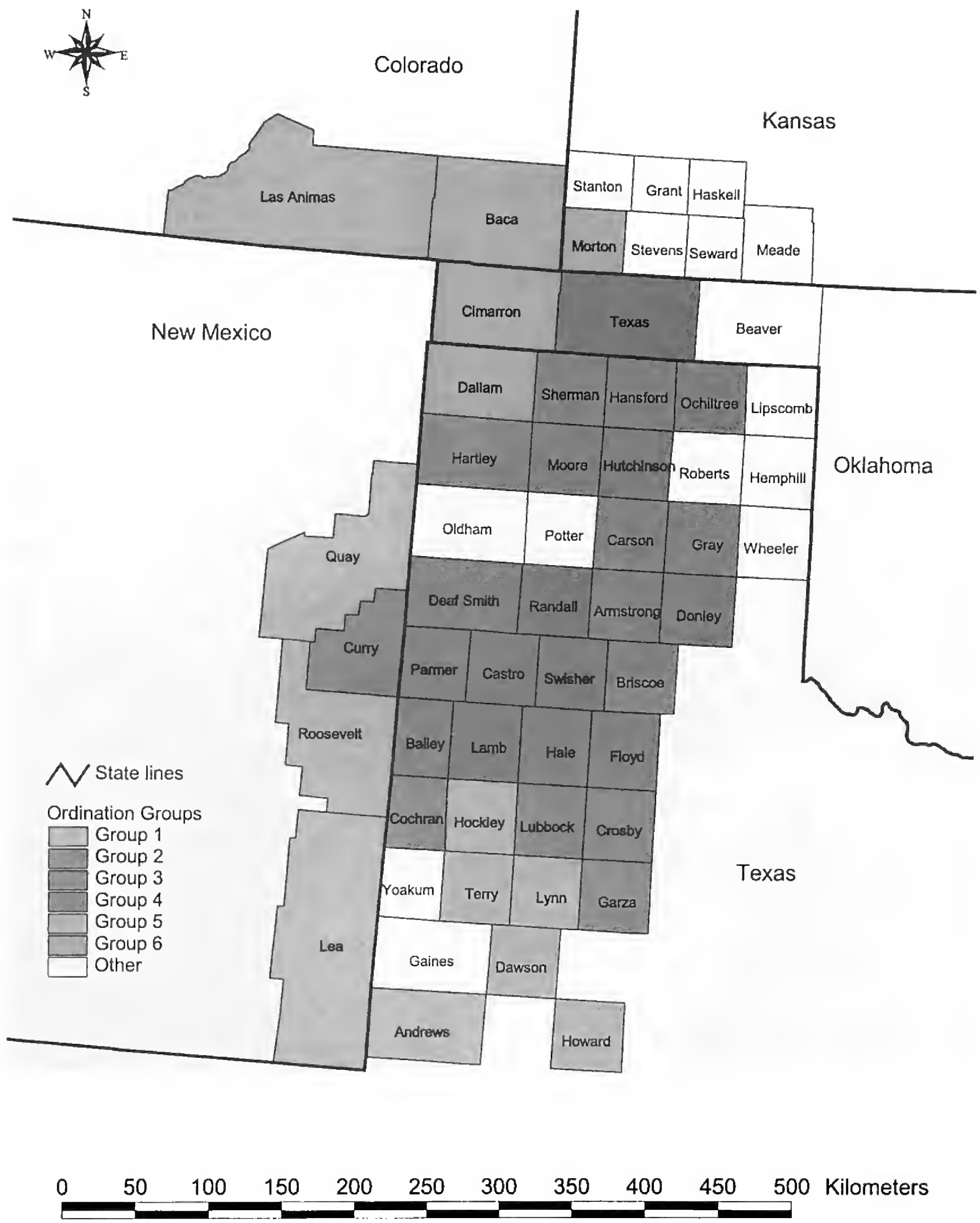

Figure 9. Groupings of counties based on cluster analyses of correspondence scores of plant communities of 224 playas in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995.

(text continued from page 11)

ordination groups ($F_{5,223}$ = 10.6, $P < 0.001$; Table 3). Overall species richness differed ($F_{5,218}$ = 4.15, P = 0.001) among ordination assemblages. Shannon's ($F_{5,218}$ = 1.7, P = 0.13) and Simpson's ($F_{5,218}$ = 1.3, P = 0.27) diversity indices did not differ among ordination assemblages. On a seasonal basis, richness differed among ordination assemblages ($F_{5,451}$ = 5.36, $P < 0.001$; Table 3). Average seasonal values of the Simpson index did not differ among ordination assemblages ($F_{5,451}$ = 1.5, P = 0.18), but did so for the Shannon index ($F_{5,451}$ = 2.1, P = 0.06; Table 3). There was no evidence of interactions ($P < 0.05$) among ordination group, land use, and disturbance for any comparison of species richness or diversity indices.

The county groupings likely reflected growing-season and precipitation gradients identified in the dimension analyses with additional grouping apparently based on land use. The groupings can be generally described as follows. Group 1 are western, small playas with grassland watersheds and lowest precipitation. Group 2 contains the largest playas, experiences the highest precipitation, and has primarily grassland watersheds or grazed cropland watersheds (e.g., winter wheat). Group 3, the center of the PLR, contains the highest density of playas, primarily cultivated watersheds planted to cotton or sorghum, and high playa disturbance. Group 4 contains playas surrounded and impacted primarily by irrigated cropland, primarily corn. The environmental conditions in Texas County, Oklahoma in 1995 resulted in conditions similar to those found in the remaining counties of Group 4, but we would not expect such similarities to occur each year. Group 5 represent the farthest south playas in the PLR with low precipitation, grassland watersheds, and small size with vegetation influenced by the neighboring Rolling Plains. Group 6 is the farthest north with relatively large playas, low precipitation, and grassland watersheds.

Plant Associations-Using cluster analyses of correspondence scores, we were able to identify species associations for all playas and those with grassland and cropland watersheds. Species within each group were more likely to occur together within a playa than with any other species. Using the common species across all playas, we identified 12 associations within playa wetlands (Table 4). However, when conducting the same analyses within land use, 14 groups were identified in cropland playas and 16 in grassland (Tables 5 and 6).

Conservation of Playas-To estimate the number of playas that need to be conserved to ensure persistence of the plants identified on transects in this study, we randomly chose sampled playas and plotted species occurrence in relation to number of playas for all and native species (Figure 10). A fourth order polynominal provided a nearly identical fit for both curves (r = 0.996).

Table 3. Average (SE) playa size (ha), seasonal species richness, Shannon's index, and Simpson's index, and overall species richness, Shannon's index, and Simpson's index for six county groups determined by cluster analysis of correspondence scores of plant communities sampled early and late in the growing season in 224 playas of 40 counties in Kansas, Colorado, Oklahoma, New Mexico, and Texas in 1995.

			Index					
			Seasonal			Overall		
Ordination Group	No. Playas	Playa Size	Richness	Simpson's	Shannon's	Richness	Simpson's	Shannon's
1	33	5.6 (0.7)D[a]	11.0 (0.6)C[a]	0.61 (0.02)	1.35 (0.06)B[a]	16.3 (1.1)C[a]	0.66 (0.03)	1.55 (0.08)
2	46	26.3 (3.5)A	14.4 (0.5)AB	0.65 (0.02)	1.47 (0.04)AB	20.9 (0.8)AB	0.70 (0.02)	1.65 (0.05)
3	84	13.5 (0.9)BC	13.0 (0.4)B	0.67 (0.01)	1.52 (0.04)AB	18.7 (0.6)BC	0.72 (0.02)	1.74 (0.05)
4	26	14.9 (1.7)B	14.5 (0.8)AB	0.68 (0.03)	1.61 (0.08)A	20.4 (1.2)AB	0.73 (0.03)	1.85 (0.09)
5	20	6.6 (0.8)CD	12.9 (0.8)B	0.68 (0.03)	1.54 (0.07)A	19.3 (1.6)BC	0.72(0.04)	1.71 (0.11)
6	15	20.8 (7.4)AB	15.1 (0.8)A	0.66 (0.03)	1.53 (0.07)AB	23.0 (1.2)A	0.69 (0.03)	1.68 (0.09)

[a]Means followed by the same uppercase letter differ ($P < 0.05$) among ordination groups within columns.

Table 4. Associations of plant species (>5% occurrence) from 224 playa wetlands from the Playa Lakes Region of 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas based on cluster analyses of scores from correspondence analyses.

Group I	Group II	Group III
Proboscidea louisianica	*Buchloë dactyloides*	*Ambrosia grayi*
Malvella leprosa	*Portulaca oleracea*	*Chenopodium leptophyllum*
Salsola iberica	*Grindelia squarrosa*	*Polygonum pensylvanicum*
Helianthus ciliaris	*Nothoscordum bivalve*	*Cyperus esculentus*
Vernonia marginata	*Leptochloa fascicularis*	*Rorippa sinuata*
Oenothera canescens		*Rumex altissimus*
Hordeum pusillum		
Verbena bracteata		
Group IV	**Group V**	**Group VI**
Lythrum californicum	*Polygonum amphibium*	*Eleocharis macrostachya*
Solanum rostratum	*Marsilea vestita*	*Helianthus annuus*
Euphorbia marginata	*Heteranthera limosa*	*Kochia scoparia*
	Sagittaria longiloba	*Rumex crispus*
		Typha domingensis
		Salix niger
		Phalaris caroliniana
		Scirpus validus
Group VII	**Group VIII**	**Group IX**
Chenopodium album	*Amaranthus retroflexus*	*Conyza canadensis*
Echinochloa crusgalli	*Suckleya suckleyana*	*Polygonum lapathifolium*
Coreopsis tinctoria	*Lepidium densiflorum*	*Haplopappus ciliatus*
Aster subulatus	*Polygonum ramosissimum*	*Sorghum halepense*
Paspalum paspalodes	*Xanthium strumarium*	*Helenium microcephalum*
		Bromus unioloides
Group X	**Group XI**	**Group XII**
Solanum elaeagnifolium	*Lippia nodiflora*	*Cuscuta squamata*
Quincula lobata	*Opuntia phaeacantha*	*Ambrosia psilostachya*
Panicum obtusum	*Ratibida columnifera*	*Panicum capillare*
Hoffmanseggia glauca	*Tragopogon dubius*	*Sitanion hystrix*
	Agropyron smithii	
	Schedonnardrus paniculatus	
	Lactuca serriola	
	Sisymbrium altissimum	
	Melilotus officinalis	

Table 5. Associations of plant species (>5% occurrence) from 126 playa wetlands with cropland watersheds from the Playa Lakes Region of 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas based on cluster analyses of scores from correspondence analyses.

Group I	Group II	Group III
Sorghum halepense	*Agropyron smithii*	*Nothoscordum bivalve*
Tragopogon dubius	*Schedonnardrus paniculatus*	*Portulaca oleracea*
Bromus unioloides		*Heteranthera limosa*
		Solanum rostratum
		Lippia nodiflora
Group IV	Group V	Group VI
Eleocharis macrostachya	*Polygonum amphibium*	*Salix niger*
Sagittaria longiloba	*Xanthium strumarium*	*Ratibida tagetes*
Polygonum pensylvanicum	*Echinochloa crusgalli*	*Panicum obtusum*
Lythrum californicum	*Verbena bracteata*	*Polygonum ramosissimum*
Aster subulatus	*Ambrosia psilostachya*	*Buchloë dactyloides*
Marsilea vestita	*Sisymbrium altissimum*	*Oenothera canescens*
Leptochloa fascicularis	*Helianthus annuus*	*Chenopodium leptophyllum*
	Cyperus esculentus	*Malvella leprosa*
		Chenopodium album
Group VII	Group VIII	Group IX
Proboscidea louisianica	*Rumex crispus*	*Quincula lobata*
Solanum elaeagnifolium	*Lepidium densiflorum*	*Suckleya suckleyana*
Amaranthus retroflexus	*Conyza canadensis*	
Group X	Group XI	Group XII
Sitanion hystrix	*Ratibida columnifera*	*Typha domingensis*
		Polygonum lapathifolium
		Scirpus validus
Group XIII	Group XIV	
Helenium microcephalum	*Cuscuta squamata*	
Hordeum pusillum	*Coreopsis tinctoria*	
Helianthus ciliaris	*Phalaris caroliniana*	
	Euphorbia marginata	
	Ambrosia grayi	
	Grindelia squarrosa	
	Vernonia marginata	
	Rorippa sinuata	

Table 6. Associations of plant species (>5% occurrence) from 98 playa wetlands with grassland watersheds from the Playa Lakes Region of 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas based on cluster analyses of scores from correspondence analyses.

Group I	Group II	Group III
Polygonum ramosissimum	*Sorghum halepense*	*Bromus unioloides*
Polygonum amphibium	*Paspalum paspalodes*	*Hordeum pusillum*
Ambrosia grayi	*Cyperus esculentus*	*Oenothera canescens*
Aster subulatus	*Polygonum pensylvanicum*	*Chenopodium leptophyllum*
Rorippa sinuata	*Rumex crispus*	*Euphorbia marginata*
Coreopsis tinctoria	*Phalaris caroliniana*	*Cuscuta squamata*
Eleocharis macrostachya		
Echinochloa crusgalli		
Leptochloa fascicularis		
Rumex altissimus		
Polygonum lapathifolium		
Group IV	Group V	Group VI
Grindelia squarrosa	*Tragopogon dubius*	*Agropyron smithii*
Helianthus annuus	*Conyza canadensis*	*Schedonnardrus paniculatus*
Amaranthus retroflexus	*Lepidium densiflorum*	*Lactuca serriola*
Helenium microcephalum	*Chenopodium album*	*Sisymbrium altissimum*
Haplopappus ciliatus	*Salsola iberica*	*Lythrum californicum*
Group VII	Group VIII	Group IX
Sagittaria longiloba	*Proboscidea louisianica*	*Solanum elaeagnifolium*
Heteranthera limosa	*Malvella leprosa*	*Lippia nodiflora*
Marsilea vestita	*Nothoscordum bivalve*	*Buchloë dactyloides*
Group X	Group XI	Group XII
Vernonia marginata	*Opuntia phaeacantha*	*Quincula lobata*
Portulaca oleracea	*Ratibida columnifera*	*Panicum obtusum*
Helianthus ciliaris	*Ambrosia psilostachya*	*Ratibida tagetes*
Hoffmanseggia glauca	*Melilotus officinalis*	
Group XIII	Group XIV	Group XV
Xanthium strumarium	*Sitanion hystrix*	*Suckleya suckleyana*
Verbena bracteata	*Kochia scoparia*	
Group XVI		
Scirpus validus		

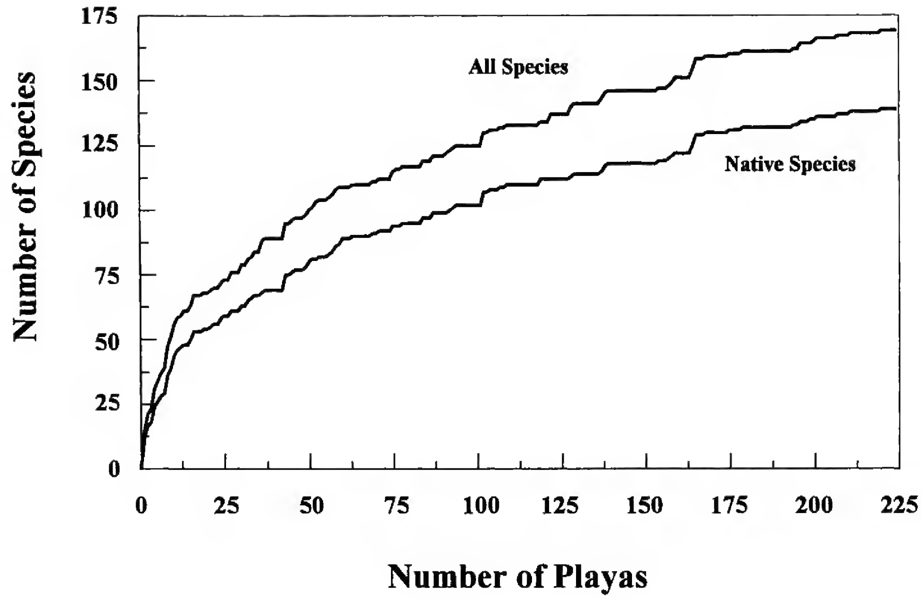

Figure 10. The relationship between the number of playas and occurrence of plant species for all and native plant species in 224 playas in 40 counties of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1995.

DISCUSSION

Plant communities in playa wetlands are complex and dynamic. We found 197 plant species in playas of the PLR. This added 64 species to the previously existing reported 282 species in playa wetlands. Because of the extensive prairie conversion to cropland, playas are important refugia for plants throughout the entire PLR. Further, plant species in playas are valuable because they form the critical wildlife habitat of the region, establish the function and structure of the playa, influence surrounding prairie ecosystems, filter water, and assist in controlling wind erosion (Bergan and Smith 1993; Sheeley and Smith 1989; Haukos and Smith 1993b; Anderson and Smith 1998, 1999; Anderson et al. 1999) .

In 1995, most of the region we surveyed had just experienced 2 years of below-average precipitation (www.srh.noaa.gov). This may have biased the results of our survey by increasing the prevalence of more xeric-adapted species than would have occurred in years with wide-spread precipitation patterns approaching average. Our surveyed playas were larger than the average size of all playas (15 compared to 6 ha) as presented by Guthery and Bryant (1982) possibly due to most of the smaller playas being unable to be surveyed because vegetation was not present. They may have been filled with sediment, cultivated, or planted to an exotic species of the Conservation Reserve Program. Further, we found no differences in playa size between grassland and cropland playas. However, those playas categorized as dry were slightly smaller (13.7 ha) than those categorized as moist (16.7 ha) or flooded (17.4 ha). Possibly this is related to playas in the southwest PLR being smaller and that region receiving less precipitation.

Variation in Playa Plant Communities.—Functioning playas have plant communities that readily adapt and respond to changes in hydrology. Dry playas are characterized by plant species more commonly found in surrounding uplands, including species of the native prairie. Playas with moist-soil conditions develop com-

munities dominated by annuals capable of producing large quantities of seed (Haukos and Smith 1993b). When flooded for at least four weeks, plant communities in playas are usually dominated by perennial submergent and emergent aquatic species. Haukos and Smith (1992) reported that taxonomic composition among playas had a higher degree of similarity in flooded relative to dry or moist conditions.

Most species of plants occur in playas throughout the PLR, albeit at varying spatial and temporal frequencies. Only a relatively small number of species actually contributed to spatial differences in plant communities among playas, within cropland and grassland playas, and among counties. Interestingly, those species contributing the most to separation of playas were those most common in either dry or flooded conditions and usually occurring throughout the playa. Only a few species are those commonly found in moist-soil conditions or restricted to the playa edge. Indeed, many moist-soil species (e.g., *Polygonum pensylvanicum*, *Echinochloa crusgalli*) will alter their growth form in response to changing environmental conditions enabling individuals to survive wetting and drying events following germination (D. Haukos, personal observation). Twenty-eight species most frequently stood out in the ordination analyses when determining the principal species contributing to separation of playas based on plant communities across different scales. The species were *Agropyron smithii*, *Ambrosia psilostachya*, *Bromus unioloides*, *Helenium microcephalum*, *Helianthus ciliaris*, *Heteranthera limosa*, *Hoffmanseggia glauca*, *Kochia scoparia*, *Lippia nodiflora*, *Malvella leprosa*, *Melilotus officinalis*, *Opuntia phaeacantha*, *Panicum obtusum*, *Polygonum amphibium*, *Polygonum lapathifolium*, *Haplopappus ciliatus*, *Quincula lobata*, *Ratibida columnifera*, *Ratibida tagetes*, *Sagittaria longiloba*, *Schedonnardrus paniculatus*, *Scirpus validus*, *Sitanion hystrix*, *Solanum elaeagnifolium*, *Sorghum halepense*, *Suckleya suckleyana*, *Tragopogon dubius*, and *Typha domingensis*.

Maintenance of plant communities in playas is dependent upon the natural water fluctuations. Without these wet-dry environmental changes, diversity and production of vegetation would be reduced (Haukos and Smith 1993a,b, 1994b, 2001). Therefore, it is essential that playas be allowed to function naturally within the landscape, and conservation efforts must strive for protection of the hydrological events that drive the playa ecosystem and maintain the diversity of native vegetation. Conversely, however, these same ephemeral environmental patterns rarely result in a stable playa floral community in playas during a growing season. Indeed, based on germination patterns from seed banks, even under continuous environmental conditions we expect the plant community to change in percent composition if not occurrence over the course of a growing season (Haukos and Smith 2001).

Considering the number of species in playas and despite the variable environment of playas, plant communities in these wetlands have remarkable predictability across land uses, soil moisture gradients, and even spatial groupings of similar communities. This is likely the result of few available niches (i.e., habitats) within playas and directly adjacent watersheds. The circular shape, short sloping edge, similar soils, and flat bottoms of playas limits variation across multiple potential gradients (e.g., depth, soil moisture, habitat permanence, soil texture, nutrients) that influence plant communities in other wetland systems (Smith and Haukos 2002).

Factors in Vegetation Development.—Understanding playa seed banks is crucial to a complete assessment of vegetation in playa wetlands. However, the only seed-bank study of playas was conducted in eight playas with cropland watersheds in three counties of the SHP. Seed banks of these playas were persistent because different species were found in seed banks than in extant vegetation (Haukos and Smith 1993a). However, given the short regeneration periods in most playas, seed banks were the prevailing source of propagules for plant communities in playas. In terms of seed density, number of taxa, and taxa life histories, seed banks of these playas resembled tidal freshwater wetlands and lakes with fluctuating water levels (Haukos and Smith 1993a). Spatial development of plant communities in playas was limited by seed availability within a playa. That is, occurrence of the species in the extant vegetation, provided suitable environmental conditions were present, was limited only by occurrence within the seed bank (Haukos and Smith 1993a, 1994b).

Haukos and Smith (1994b) also found few differences in overall or common species seedling densities in the seed bank from the edge to the center of playas supporting the hypotheses that habitat diversity drives playa plant diversity (Smith and Haukos 2002). Fluctuating water levels in a relatively shallow wetland, combined with the short linear distance of the potential elevation gradient into a flat bottom, results in the uniform distribution of seed in playas that in turn contributes to the lack of plant zonation within playas. None of the sampled playas had developed distinct changes in community composition along transects. However, a few species are typically restricted to the playa edge (e.g., *Oenothera canescens*, *Panicum obtusum*, *Lippia nodiflora*, and *Malvella leprosa*). This plant zonation within playas was also reported by Hoaglund and Collins (1997) in the northwestern PLR. Their results indicated that within the hydric-soil defined playa there existed two zones of vegetation, the interior playa vegetation and the edge. Surrounding the playa, they reported another two zones, the upland adjacent to the playa and then the outer shortgrass prairie vegetation.

Species in seed banks of playas have evolved mixed strategies of differential temporal emergence in response to the unpredictable playa environment (Haukos and Smith 2001). Species persisting in seed banks of playas do not germinate all available seeds upon creation of suitable environmental conditions because viable ungerminated seeds remain as a hedge against the unpredictable environment (Haukos and Smith 2001). These life-history strategies associated with the seed bank allow each playa to respond rapidly and appropriately to changes in the environment, maintaining the importance of playas as a critical part of the ecosystem of the Southern Great Plains. Any impacts affecting the seed bank of playas will have significant influence on subsequent extant plant communities in these wetlands.

Another aspect influencing establishment and development of playa plant communities is the attribute of a closed watershed. Closed watersheds somewhat limit colonization of plants from other playas; thus increasing the importance of an available seed bank. The preference of waterfowl and other birds for the plants found in moist-soil conditions may have led to the documented widespread dispersal of these species (e.g., *Polygonum pensylvanicum*, *Rumex crispus*, *Echinochloa crusgalli*, *Eleocharis macrostachya*) and thus the lack of these species as contributors to the spatial or temporal separation of plant communities in ordination analyses. Typically, given the isolated nature of playas and precipitation events in the PLR, different plant communities develop even between adjacent playas.

Development of Playa Plant Communities.—Based on extant aboveground vegetation, the overall species pool for all playas of the PLR is nearly 350 species. However, from ordination analyses, the potential species pool for groupings of playas across counties is approximately 100 and at the county scale the species pool averages 43 species. At the individual playa scale, potential species pool averages 19 species. However, we only examined extant vegetation and did not consider the composition of playa seed banks. When considering both seed banks and extant vegetation at the playa scale, average species richness was 28.7 species for eight cropland playas (Haukos 1991).

When examining patterns of community composition of vegetation in playas, at any scale, a considerable number of multivariate dimensions were needed to explain the variation of plant communities among playas even with data reduction through ordination. Therefore, plant species in playas are likely responding to a number of varying scale environmental gradients, including short- and long-term site specific conditions, changes in watershed composition, and, perhaps, several undiscovered situations (e.g., nutrients, pesticides, food web disruption). The most likely important gradients affecting spatial variation of plant community composition in playas throughout the PLR was growing-season length and average long-term precipitation. These regional gradients were the primary determinants of species occurrence in playa communities because the similarity of available playa niches among regions resulted in only spatial changes of species occupying these niches. For example, the niche of playa-edge, warm-season grass is occupied primarily by *Agropyron smithii* north of the Canadian River, but *Panicum obtusum* dominants south of the river.

Membership within the extant plant community in playas is based on three factors. First, the location

of the playa in the regional growing season (north-south) and precipitation (west-east) gradients influences the potential species available within the landscape to exploit the few playa niches (e.g., playa floor and playa edge). Second, the composition of the underlying seed bank, which constitutes those species available within each playa, is established by past environmental events that dictated the regeneration niches allowing for additions both in terms of seed occurrence and density (Haukos and Smith 1993a). Third, local environmental conditions establish the germination conditions for the species present in the seed bank (Haukos and Smith 1993a).

Spatial Variation at the Landscape Level.— Spatial separation of communities at the county level indicated 6 groupings. These groupings included playas that had similar attributes (e.g., size, watershed type) and, with only a few exceptions, grouped counties were adjacent with similar positions along the growing-season and average-precipitation regional gradients. A possibility for inclusion of the three counties not adjacent to their groups (e.g., Texas, Oklahoma, in Group 4, Hutchinson, Texas, in Group 3) would be that localized environmental conditions during 1995 resulted in plant community establishment that differed from contiguous counties and was similar to another county group.

Species Diversity.—It is obvious that community composition of vegetation in playas changes across the PLR, but species richness and diversity within playas varied little temporally or spatially allowing for remarkable predictability of these community attributes. Seasonally and overall, species richness was similar between watershed types, soil-moisture categories, and disturbance categories. Although species richness differed among county groupings, the range of richness values was rather narrow (89 - 104) considering the size of the PLR. Across seasons, Simpson's and Shannon's diversity indices did not differ between watershed types, but Shannon's diversity was greater in cropland playas when considering all playas. Both diversity indices differed among soil moisture categories with moist playas having higher diversity than flooded or dry playas. Interestingly, for all playas neither diversity index differed among county groups, but values of the Shannon's index did for averaged seasonal values across groups. Shannon's index gives relatively greater weight to "rare" species than Simpson's (Magurran 1988). Therefore, data based on the Shannon's index indicates that relatively rare species contribute to differences among categories, watershed types, and groups.

Plant Associations.—Plant associations represent groupings of species that are most likely to occur together. Few associations contained the same species across all playas and for playas separated by watershed type. The associations determined for playas with grassland watersheds best grouped species with similar ecological requirements. Examples are moist-soil species, playa edge species, and the upland species associated with dry playas in different groups. Previous efforts to group plants in playas resulted in a similar number of groups. However our groups do contain more species within each group compared to earlier studies (Penfound 1953; Guthery et al. 1982; Hoaglund and Collins 1997).

Impact of Disturbance on Diversity.— Rosenzweig (1995:36) indicated that intermediate levels of disturbance might have the highest diversity and species richness primarily because of the increased number of species that could potentially exploit intermediate environmental conditions. For plant species in playa wetlands, species richness and Simpson's diversity index were similar among disturbance categories. Shannon's diversity index was higher in playas that experienced intermediate levels of disturbance. Further, diversity measures differed among soil-moisture categories where moist conditions resulted in higher richness and diversity. This is likely because of the intermediate nature of these conditions that allow for potential establishment of a greater numbers of species compared to the relative dry and flooded conditions.

However, the disturbance factor of watershed cultivation has a much greater affect on composition (e.g., annuals vs perennials) of the community compared to species richness or diversity. In most freshwater wetlands, seed banks are dominated by perennials (van der Valk and Pederson 1989). However, in examination of playas with cropland watersheds, Haukos and Smith (1993a) found that seed banks were dominated by annuals. Based on data from this study, Smith and Haukos (2002) found that cropland playas

had more exotic species and more annuals (numbers and percent coverage) than those surrounded by grassland.

Other Ecological Attributes of Communities.—Our assessment of community composition did not include measurement of other community attributes (e.g., production, nutrient cycling, decomposition,) that are also important aspects of wetland ecosystem structure and function. Previous work has indicated that playas can be as or more productive than other freshwater wetlands (Smith 1988; Haukos and Smith 1993b; Smith and Haukos 1995; Anderson and Smith 1999, 2000). However, production under unmanaged conditions are exceedingly variable (Haukos and Smith 1993b) such that accurately estimating annual production for management purposes across local, regional, or even the entire PLR scales may be difficult. Haukos and Smith (1996) found that management of playas did not affect soil nitrogen and phosphorus levels. However, they concluded that nutrient availability in playa soils was determined by regional environmental conditions with nitrogen potentially limiting plant production in wet years and phosphorus potentially limiting in dry years.

Very little is known about energy flow and nutrient cycling in playas. Smith (1988) reported that there was little vertebrate herbivory in playas dominated by *Typha domingensis*, with all vegetation entering the detrital food web. However, Haukos (1992) reported that *Gastrophysa dissimilis* (Coleoptera: Chrysomelidae) inflicted a significant (20-60%) amount of herbivory on *Polygonum amphibium*. As hypothesized, Anderson and Smith (2002) found that decomposition and subsequent nutrient cycling in playas was rapid. The natural source pool for nutrients in playas is the extant vegetation and not organic matter in the soil because playa soils contain less than 1% organic matter (Luo 1994) with lower nitrogen and phosphorus levels than soils of other freshwater wetlands (Haukos and Smith 1996). However, the influence of runoff transporting chemical and organic constituents on playa plant communities is difficult to assess. Further, rates of nutrient input, export, mineralization, and transformations in playas are unknown and need to be researched to further understand and model playa ecosystems.

Conservation of Playa Plant Communities.—Conservation of 50 playas would allow for the persistence of 100 species, 80 being native. Protecting 100 playas should ensure the persistence of 125 species and 102 native species. However, because of the lack of an upper asymptote, it is evident that protection of several hundred playas is needed to ensure persistence of all, including native, plant species within playas. Unfortunately, less than 30 playas have been permanently protected out of 25,000 in the Southern Great Plains. Thus far, the record of conservation agencies and groups in the PLR has been very poor.

The primary threat to playas is accumulation of sediment through water erosion of the surrounding watershed. Luo et al. (1997) found that playas with cultivated watersheds contained more sediment than those surrounded by perennial grassland, and they had lost their original volume. The accumulation of sediment reduces wetland volume, interferes with the shrinking and swelling capacity of the hydric clay soils, causes water to accumulate on more permeable soils shortening flood duration, and buries seed banks. Burying of seed banks is critical because (1) it diminishes the pool of species available to respond to changing environment, thus reducing biodiversity and (2) local extirpations of plants may occur.

Because of their keystone ecosytem status, periodic assessment and appraisal of plant communities in playa wetlands in the PLR should be conducted to evaluate change in the ecology of playas. These wetlands are critical to continued existence of any natural communities in the region. Although playas are relatively resistant to most negative impacts, there has not yet been a documented successful restoration of a severely impacted SHP playa. Haukos and Smith (2003) outlined several steps that must be taken to ensure conservation of playas and their associated unique plant communities including (1) increased promotion and implementation of existing federal and state conservation programs specifically for playas; (2) proposed state regulations for playa conservation; (3) recognition of agricultural impacts on wetland determinations; (4) creation of Federal Wetland Management Districts to preserve intact, functioning playas; and (5) increased public education on the value of playas. We urge all entities associated with the conservation of playas to carefully consider the ecological and economic costs associated with continued impairment or loss of playa wetlands.

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APPENDIX I

Frequency of occurrence (in order of occurrence) during 2 sampling periods (early and late season) and percent community composition in 3 soil moisture regimes (dry, moist, flooded) and sampling period of 197 plant species in 233 playa wetlands of 40 counties in the Playa Lakes Region of Texas, New Mexico, Oklahoma, Colorado, and Kansas during 1995. Ordination codes are a reference for species abbreviations on the ordination diagrams (Figures 3 – 7).

					% Total Community Composition					
	Ordination	# of Surveyed Playas			Soil Moisture			Season		
Species	Code	Early	Late	Total	Dry	Moist	Flooded	Early	Late	Total
Ambrosia grayi	AMGR	70.5	73.7	76.0	15.79	15.77	7.48	12.50	15.91	14.21
Eleocharis macrostachya	ELPL	61.7	63.2	72.1	8.80	18.41	20.74	15.13	11.83	13.47
Malvella leprosa	MALE	64.3	58.8	70.4	6.61	4.67	1.02	5.04	4.25	4.64
Helianthus ciliaris	HECI	57.7	51.3	68.2	2.34	1.21	0.82	2.06	1.53	1.73
Oenothera canescens	OECA	60.8	49.1	67.8	1.62	0.86	0.22	1.43	0.86	1.14
Kochia scoparia	KOSC	47.1	49.6	61.8	6.20	2.50	0.58	3.55	5.02	4.22
Polygonum pensylvanicum	POPE	39.6	48.2	54.9	3.56	4.72	3.23	2.33	4.52	3.56
Buchloë dactyloides	BUDA	47.6	41.7	54.5	5.98	3.69	1.54	5.37	3.36	4.40
Chenopodium leptophyllum	CHLE	33.0	41.7	52.4	1.80	0.89	0.18	1.40	1.09	1.24
Chenopodium album	CHAL	37.4	39.0	51.9	1.13	0.63	0.25	0.74	0.99	0.87
Echinochloa crusgalli	ECCR	16.3	48.7	51.5	2.77	3.18	1.55	0.31	4.64	2.47
Rorippa sinuata	ROSI	41.9	18.9	46.4	0.41	0.65	0.47	0.77	0.13	0.45
Lippia nodiflora	LINO	31.7	32.0	43.8	1.22	0.47	0.31	0.92	0.87	0.89
Rumex crispus	RUCR	35.2	30.3	41.6	0.96	1.66	0.99	1.20	1.04	1.12
Solanum elaeagnifolium	SOEL	29.5	24.1	40.3	0.25	0.24	0.15	0.24	0.21	0.22
Agropyron smithii	AGSM	28.2	25.4	33.0	4.86	1.30	3.17	4.38	3.79	4.02
Hordeum pusillum	HOPU	32.2	0.4	31.3	0.69	0.23	0.08	0.94	0.00	0.47
Amaranthus retroflexus	AMSP	13.2	21.5	29.6	0.54	0.88	0.12	0.34	0.57	0.45
Grindelia squarrosa	GRSQ	18.1	21.5	28.8	0.38	0.52	0.24	0.33	0.37	0.35
Helianthus annuus	HEAN	10.6	24.6	27.9	0.67	0.22	0.21	0.13	0.74	0.43
Aster subulatus	ASSU	15.9	25.9	27.0	0.69	2.43	0.83	0.58	1.22	0.91
Panicum obtusum	PAOB	18.1	15.8	26.6	0.82	0.86	0.03	0.72	0.48	0.60
Conyza canadensis	COCA	17.2	16.2	25.3	0.34	0.23	0.05	0.26	0.23	0.25
Verbena bracteata	VEBR	17.2	13.2	25.3	0.18	0.15	0.05	0.13	0.15	0.14
Sorghum halepense	SOHA	15.0	14.9	22.3	0.64	0.75	0.24	0.36	0.72	0.54
Polygonum ramosissimum	PORA	11.5	15.4	21.5	0.16	0.15	0.14	0.15	0.15	0.15
Paspalum paspalodes	PAPA	12.8	18.4	20.6	0.95	5.88	1.63	1.13	2.22	1.65
Lythrum californicum	LYCA	6.2	16.7	20.6	0.27	0.77	0.12	0.14	0.42	0.28
Salsola iberica	SAIB	10.1	15.4	20.2	0.14	0.02	0.01	0.04	0.15	0.09
Lactuca serriola	LASE	11.5	15.4	19.7	0.18	0.17	0.01	0.16	0.10	0.13
Solanum rostratum	SORO	4.4	16.2	18.0	0.08	0.69	0.01	0.01	0.24	0.13
Polygonum amphibium	POAM	11.5	14.9	18.0	0.90	2.29	4.44	1.66	2.70	2.17
Coreopsis tinctoria	COTI	14.5	12.3	16.3	0.77	0.18	0.19	0.68	0.42	0.55
Schedonnadrus paniculatus	SCPA	10.6	11.8	16.3	0.24	0.07	0.05	0.14	0.20	0.17
Marsilea vestita	MAVE	9.7	10.1	15.9	0.24	0.04	0.48	0.20	0.38	0.29
Polygonum lapathifolium	POLA	7.9	12.7	15.5	1.17	0.25	0.38	0.53	1.15	0.84
Ratibida tagetes	RATA	7.5	9.2	13.7	0.30	0.02	0.01	0.20	0.18	0.19
Sagittaria longiloba	SALO	4.8	12.3	13.3	0.41	0.90	0.83	0.18	0.99	0.58
Xanthium strumarium	XAST	7.1	7.5	13.3	0.05	0.02	0.01	0.00	0.06	0.03
Vernonia marginata	VEMA	5.7	10.5	12.9	0.05	0.05	0.04	0.04	0.06	0.05
Portulaca oleracea	POOL	4.4	10.1	12.9	0.13	0.69	0.03	0.02	0.30	0.16
Opuntia phaeacantha	OPPH	8.8	8.3	12.0	0.05	0.00	0.01	0.02	0.04	0.03
Bromus unioloides	BRUN	11.9	0.9	12.0	0.24	0.19	0.20	0.39	0.06	0.33
Euphorbia marginata	EUMA	2.2	11.0	11.6	0.06	0.04	0.00	0.01	0.07	0.04
Suckleya suckleyana	SUSU	4.8	9.2	11.6	0.70	0.00	0.47	0.24	0.88	0.56

Appendix I. (cont.)

					% Total Community Composition					
	Ordination	# of Surveyed Playas			Soil Moisture			Season		
Species	Code	Early	Late	Total	Dry	Moist	Flooded	Early	Late	Total
Scirpus validus	SCSP	6.6	10.5	11.2	0.55	0.93	1.17	0.56	0.98	0.77
Hoffmannseggia glauca	HOGL	7.5	6.6	11.2	0.05	0.14	0.03	0.07	0.04	0.06
Typha domingensis	TYDO	6.6	10.5	10.7	1.24	1.21	1.23	1.17	1.30	1.23
Tragopogon dubius	TRDU	8.8	3.5	10.7	0.03	0.00	0.00	0.03	0.01	0.02
Cyperus esculentus	CYES	3.1	8.8	10.3	0.04	0.00	0.02	0.02	0.04	0.03
Lepidium densiflorum	LEPE	10.1	0.4	9.9	0.07	0.00	0.01	0.08	0.00	0.04
Rumex altissimus	RUAL	5.3	8.3	9.0	0.36	0.27	0.23	0.32	0.32	0.32
Cuscuta squamata	CUSQ	1.3	8.3	8.6	0.05	0.00	0.00	0.00	0.06	0.03
Leptochloa fascicularis	LEFA	0.4	9.2	9.4	0.04	0.00	0.02	0.00	0.06	0.03
Phalaris caroliniana	PHCA	8.8	0.0	8.6	0.29	1.60	0.27	0.84	0.00	0.42
Panicum capillare	PACA	0.0	8.3	8.2	0.06	0.01	0.00	0.00	0.08	0.04
Helenium microcephalum	HEAM	7.0	6.6	8.6	0.19	0.05	0.32	0.22	0.22	0.22
Proboscidea louisianica	PRLO	0.8	7.0	7.7	0.01	0.01	0.01	0.00	0.02	0.01
Nothoscordum bivalve	NOBI	7.5	0.4	7.7	0.01	0.00	0.01	0.02	0.00	0.01
Salix nigra	SANI	6.6	7.9	7.7	0.19	0.01	0.01	0.12	0.13	0.12
Heteranthera limosa	HELI	1.3	6.1	7.3	0.01	0.25	0.33	0.00	0.25	0.12
Haplopappus ciliatus	PRCI	2.6	5.3	6.9	0.05	0.01	0.01	0.01	0.05	0.03
Sitanion hystrix	SIHY	6.6	2.6	6.9	0.18	0.00	0.00	0.21	0.01	0.11
Ratibida columnifera	RACO	3.1	3.9	6.4	0.03	0.02	0.00	0.02	0.02	0.02
Melilotus officinalis	MEOF	5.3	3.5	6.0	0.13	0.00	0.01	0.10	0.06	0.08
Sisymbrium altissimum	SIAL	6.2	0.0	6.0	0.02	0.10	0.00	0.04	0.00	0.02
Quincula lobata	QULO	6.2	0.4	6.0	0.01	0.00	0.01	0.01	0.00	0.01
Aristida purpurea	ARPU	4.8	2.6	5.6	0.15	0.00	0.00	0.16	0.02	0.09
Ambrosia psilostachya	AMPS	3.5	3.5	5.6	0.07	0.01	0.00	0.04	0.05	0.05
Sphaeralcea coccinea	SPCO	4.8	1.3	5.2	0.02	0.00	0.00	0.02	0.00	0.01
Ammannia auriculata	AMAU	0.4	4.8	5.2	0.00	0.00	0.01	0.00	0.02	0.01
Cynodon dactylon	CYDA	3.1	3.5	4.7	0.12	0.03	0.00	0.04	0.12	0.08
Sophora nuttalliana	SONU	3.1	2.2	4.7	0.05	0.00	0.00	0.05	0.01	0.03
Descurainia pinnata	DEPI	4.4	0.4	4.7	0.00	0.04	0.00	0.02	0.00	0.01
Sporobolus cryptandrus	SPCR	1.3	4.4	4.3	0.37	0.00	0.00	0.26	0.19	0.23
Euphorbia albomarginata	EUAL	0.8	3.1	3.9	0.03	0.02	0.00	0.00	0.03	0.02
Chloris verticillata	CHVE	2.2	1.7	3.9	0.04	0.00	0.00	0.03	0.01	0.02
Astragalus mollissimus		3.5	0.9	3.9	0.00	0.00	0.00	0.00	0.00	0.00
Bromus japonicus	BRJA	4.0	0.4	3.9	0.05	0.00	0.03	0.09	0.00	0.04
Picradeniopsis woodhousi	PIWO	3.5	0.9	3.9	0.10	0.00	0.01	0.12	0.00	0.06
Machaeranthera tanacetifolia	MATA	3.1	0.4	3.4	0.01	0.10	0.00	0.03	0.00	0.01
Tamarix gallica	TASP	3.1	3.1	3.0	0.03	0.00	0.04	0.04	0.02	0.03
Gutierrezia sarothrae	GUSA	1.3	2.6	3.0	0.06	0.00	0.00	0.02	0.05	0.04
Prosopis glandulosa	PRGL	2.6	2.2	3.0	0.01	0.00	0.00	0.00	0.01	0.00
Opuntia imbricata	OPIM	2.2	2.2	3.0	0.01	0.00	0.00	0.00	0.01	0.01
Croton dioicus	CRDI	2.2	1.7	3.0	0.03	0.00	0.00	0.03	0.01	0.02
Convolvulus equitans	COEQ	3.1	0.9	3.0	0.01	0.04	0.00	0.01	0.00	0.01
Portulaca mundula		0.9	2.2	2.6	0.00	0.00	0.00	0.00	0.00	0.00
Bothriochloa laguroides	ANSA	1.3	1.3	2.6	0.07	0.00	0.00	0.01	0.08	0.04
Heterotheca latifolia	HELA	1.8	0.9	2.6	0.01	0.02	0.00	0.01	0.00	0.01
Mimosa borealis		2.6	2.6	2.6	0.00	0.00	0.00	0.00	0.00	0.00
Helianthus petiolaris	HEPE	2.6	0.0	2.6	0.01	0.00	0.01	0.01	0.00	0.01
Hordeum jubatum	HOJU	0.9	1.7	2.2	0.19	0.03	0.06	0.22	0.05	0.13
Plantago patagonica	PLPA	0.0	2.2	2.1	0.01	0.00	0.00	0.00	0.02	0.01
Hymenoxys odorata	HYOD	3.5	0.4	3.4	0.00	0.09	0.00	0.02	0.00	0.01
Ulmus pumila		1.8	1.7	2.1	0.00	0.00	0.00	0.00	0.00	0.00
Populus deltoides		0.9	1.7	1.7	0.00	0.00	0.00	0.00	0.00	0.00

Appendix I. (cont.)

					% Total Community Composition					
	Ordination	# of Surveyed Playas			Soil Moisture			Season		
Species	Code	Early	Late	Total	Dry	Moist	Flooded	Early	Late	Total
Panicum dichotomiflorum	PADI	0.0	1.7	1.7	0.00	0.06	0.00	0.00	0.01	0.01
Sagittaria calycina	SACA	0.0	1.7	1.7	0.03	0.00	0.01	0.00	0.04	0.02
Tridens albescens	TRAL	0.9	1.3	1.7	0.01	0.00	0.00	0.00	0.01	0.00
Polygonum aviculare		0.9	0.9	1.7	0.00	0.00	0.00	0.00	0.00	0.00
Physalis viscosa	PHVI	1.7	0.4	1.7	0.00	0.01	0.00	0.01	0.00	0.00
Lesquerella gordonii		1.7	0.0	1.7	0.00	0.00	0.00	0.00	0.00	0.00
Erodium cicutarium	ERCI	1.8	0.0	1.7	0.00	0.01	0.00	0.00	0.00	0.00
Gaura coccinea	GACO	1.8	0.0	1.7	0.01	0.00	0.00	0.01	0.00	0.01
Scirpus acutus		0.0	1.8	1.7	0.00	0.00	0.00	0.00	0.00	0.00
Ammannia coccinea		0.0	1.8	1.7	0.00	0.00	0.00	0.00	0.00	0.00
Bacopa rotundifolia		0.0	1.3	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Gutierrezia dracunculoides		0.0	1.3	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Elymus canadensis	ELCA	0.9	0.9	1.3	0.01	0.00	0.00	0.01	0.00	0.00
Bouteloua gracilis		0.9	0.4	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Cirsium undulatum		1.3	0.0	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Euphorbia dentata	EUDE	0.4	0.9	1.3	0.00	0.00	0.01	0.00	0.00	0.00
Xanthisma texanum		1.3	0.0	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Senecio douglassii		0.9	0.4	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Potamogeton nodosus	PONO	0.0	1.3	1.3	0.00	0.00	0.26	0.00	0.15	0.07
Echinodorus rostratus	ECRO	0.0	1.3	1.3	0.00	0.00	0.08	0.00	0.05	0.02
Eleocharis parvula	ELDW	1.3	0.0	1.3	0.03	0.00	0.00	0.04	0.00	0.02
Salix amygdaloides	SAAM	0.9	1.3	1.3	0.06	0.00	0.00	0.04	0.04	0.04
Salix exigua	SAEX	1.3	1.3	1.3	0.04	0.00	0.00	0.01	0.04	0.02
Allium drummondii		1.3	0.0	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Heteranthera mexicana		0.0	1.3	1.3	0.00	0.00	0.00	0.00	0.00	0.00
Desmanthus illinoensis		0.0	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Sphaeralcea hastulata	SPHA	0.0	0.9	0.9	0.01	0.00	0.00	0.00	0.01	0.00
Scirpus maritimus	SCMA	0.9	0.9	0.9	0.03	0.00	0.02	0.03	0.02	0.02
Asclepias verticillata		0.0	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Setaria glauca		0.0	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Gaura villosa	GAVI	0.9	0.4	0.9	0.01	0.01	0.00	0.01	0.01	0.01
Sporobolus airoides		0.4	0.4	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Potamogeton pectinatus	POPC	0.4	0.4	0.9	0.00	0.00	0.03	0.00	0.02	0.01
Echinocactus texensis		0.9	0.0	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Typha latifolia		0.4	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Lippia cuneifolia		0.9	0.4	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Engelmannia pinnatifida		0.9	0.0	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Evolvulus nuttallianus	EVNU	0.9	0.0	0.9	0.01	0.00	0.00	0.02	0.00	0.01
Gaura angustifolia		0.9	0.0	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Linum pratense	LIPR	0.9	0.0	0.9	0.00	0.07	0.00	0.01	0.00	0.01
Scirpus americanus		0.4	0.4	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Polypogon monspeliensis		0.0	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Asclepias engelmanniana		0.4	0.4	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Iva axillaris	IVAX	0.9	0.0	0.9	0.20	0.00	0.00	0.24	0.00	0.12
Potentilla rivalis	PORI	0.9	0.0	0.9	0.01	0.00	0.00	0.02	0.00	0.01
Scirpus saximontanus		0.4	0.4	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Thelesperma simplifaluim	THME	0.9	0.0	0.9	0.00	0.02	0.00	0.03	0.00	0.01
Erysimum asperum		0.4	0.4	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Amaranthus palmeri		0.0	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Eleocharis atropurpurea		0.0	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Aristida pansa		0.0	0.9	0.9	0.00	0.00	0.00	0.00	0.00	0.00
Dyssodia acerosa		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00

Appendix I. (cont.)

					% Total Community Composition					
	Ordination	# of Surveyed Playas			Soil Moisture			Season		
Species	Code	Early	Late	Total	Dry	Moist	Flooded	Early	Late	Total
Dyssodia papposa	DYPA	0.0	0.4	0.4	0.02	0.00	0.00	0.00	0.03	0.00
Asclepias latifolia		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Muhlenbergia porteri		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Andropogon barbinodis		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Munroa squarrosa		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Tribulus terrestris		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Eragrostis curtipedicellata		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Panicum coloratum		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Lemna spp.		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Mentzelia nuda		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Sisyrinchium spp.		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Antennaria parvifolia		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Ruppia maritima	RUMA	0.0	0.4	0.4	0.00	0.00	0.71	0.00	0.40	0.20
Eragrostis pectinacea		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Alopecurus carolinianus		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Achillea millefolium		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Convolvulus arvensis		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Erodium texanum		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Gaillardia pulchella		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Hilaria jamesii		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Setaria viridis		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Andropogon scoparius		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Machaeranthera bigelorvii	MABI	0.4	0.0	0.4	0.00	0.00	0.01	0.00	0.00	0.00
Muhlenbergia repens	MURE	0.4	0.0	0.4	0.00	0.03	0.00	0.01	0.00	0.00
Bothriochloa ischaemum	OWBL	0.4	0.0	0.4	0.00	0.01	0.00	0.00	0.00	0.00
Najas guadalupensis	NAGU	0.0	0.4	0.4	0.00	0.00	0.07	0.00	0.04	0.02
Artemisia filifolia		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Senecio longilobus		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Senecio ampullaceus		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Setaria verticillata		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Bouteloua curtipendula		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Capsella bursa-pastoris	CABU	0.4	0.0	0.4	0.01	0.00	0.00	0.01	0.00	0.00
Sonchus asper		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Dimorphocarpa palmeri		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Sphaeralcea angustifolia		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Panicum virgatum		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Festuca arundinacea		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Thelesperma megapotamicum		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Eragrostis cilianensis		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Eragrostis curvula		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Amaranthus spinosus		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Descurainia richardsonii		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Cucurbita foetidissima		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Melilotus alba		0.4	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Andropogon ischaemum		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Festuca pratensis		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum argyrocoleon		0.0	0.4	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Mimosa strigalosa		0.4	0.0	0.4	0.00	0.00	0.00	0.00	0.00	0.00
Unknown Individuals		44.1	46.1	87.6	1.09	1.50	0.85	1.12	1.01	1.06
Bare Ground (soil/water)	WADI	81.9	72.4	88.8	7.80	7.08	34.00	19.52	11.00	15.25
Dead Vegetation	DEVE	40.5	57.0	70.8	6.39	5.92	4.21	4.31	7.26	5.78

APPENDIX II

Frequency of occurrence[a] across (overall; listed in overall frequency order) and within 2 sampling periods (early and late season) as well as for 3 soil moisture regimes (dry, moist, flooded) by watershed type (cropland n = *134; grassland* n = *99 playas) in 233 playa wetlands of 40 counties in the Playa Lakes Region of Texas, New Mexico, Oklahoma, Colorado, and Kansas during 1995.*

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Ambrosia grayi	65.6	82.9	63.3	62.6	77.2	83.5	59.3	62.5	80.0	77.4	76.5	82.6
Eleocharis macrostachya	70.7	72.4	67.3	61.6	60.6	63.0	56.6	75.0	91.4	57.4	67.6	65.2
Malvella leprosa	69.7	71.6	65.3	63.6	65.4	58.3	64.1	81.3	60.0	65.8	67.6	46.4
Helianthus ciliaris	73.7	63.4	63.3	56.6	55.1	40.9	63.4	68.8	42.9	50.3	50.0	40.6
Oenothera canescens	65.6	68.7	60.2	47.5	61.4	48.8	55.9	56.3	45.7	64.5	47.1	34.8
Kochia scoparia	47.5	71.6	33.7	37.4	59.1	56.7	40.0	18.8	25.7	63.9	44.1	47.8
Polygonum pensylvanicum	31.3	73.1	24.5	25.3	52.8	67.7	20.0	18.8	45.7	62.6	50.0	55.1
Buchloë dactyloides	87.8	29.8	77.6	72.7	26.8	26.8	77.2	87.5	62.9	25.2	14.7	20.3
Chenopodium leptophyllum	51.5	53.7	31.6	40.4	35.4	44.1	41.4	18.8	25.7	47.1	29.4	26.1
Chenopodium album	29.3	68.7	20.4	24.2	52.8	52.8	26.9	6.3	11.4	56.1	38.2	49.3
Echinochloa crusgalli	27.3	71.7	5.11	8.2	26.0	68.5	15.2	25.0	20.0	50.3	41.2	43.5
Rorippa sinuata	29.3	61.9	25.5	13.1	57.5	27.6	14.5	31.3	34.3	36.1	55.9	49.3
Lippia nodiflora	62.6	29.9	44.9	53.5	22.8	15.0	49.7	62.5	42.9	18.7	5.9	27.5
Rumex crispus	18.2	57.5	14.3	10.1	51.2	43.3	8.3	12.5	28.6	43.9	50.0	50.7
Solanum elaeagnifolium	44.4	35.8	35.7	30.3	26.8	18.9	36.6	31.3	25.7	26.5	17.6	15.9
Agropyron smithii	42.4	24.6	36.7	36.4	21.3	15.7	35.9	18.8	48.6	11.6	23.5	44.9
Hordeum pusillum	35.4	27.6	36.7	0.0	27.6	0.0	15.9	25.0	25.7	14.2	11.8	11.6
Amaranthus retroflexus	17.2	38.8	10.2	12.1	15.7	29.9	13.1	12.5	2.9	23.2	17.6	15.9
Grindelia squarrosa	65.6	22.4	21.4	30.3	14.2	15.0	29.0	18.8	14.3	13.5	23.5	14.5
Helianthus annuus	19.2	33.8	10.2	16.2	13.4	28.3	11.0	12.5	22.9	20.0	35.3	17.4
Aster subulatus	15.2	38.1	8.21	5.2	21.3	37.0	8.3	12.5	25.7	26.5	32.4	31.9
Panicum obtusum	35.3	20.1	23.5	26.3	15.0	7.9	25.5	43.8	14.3	11.6	20.6	8.7
Conyza canadensis	17.2	28.4	11.2	8.1	22.8	21.3	7.6	12.5	17.1	21.3	29.4	23.2
Verbena bracteata	29.3	21.8	19.4	15.2	15.0	11.8	19.3	25.0	5.7	16.8	5.9	8.7
Sorghum halepense	3.0	34.4	1.02	0.0	25.2	24.4	0.7	0.0	5.7	27.1	20.6	20.3
Polygonum ramosissimum	23.2	18.6	10.2	19.2	12.6	12.6	13.8	12.5	20.0	14.2	11.8	5.8
Paspalum paspalodes	10.1	27.6	9.21	0.1	16.5	23.6	4.8	12.5	28.6	17.4	26.5	21.7
Lythrum californicum	4.0	17.9	5.12	1.2	6.3	13.4	11.7	25.0	17.1	6.5	20.6	14.5
Salsola iberica	20.2	21.6	13.3	13.1	8.7	18.9	15.9	6.3	5.7	20.0	2.9	4.4
Lactuca serriola	13.1	24.6	8.2	7.1	14.2	21.3	9.0	0.0	5.7	23.9	2.9	7.3
Solanum rostratum	25.3	13.4	4.12	4.2	3.9	11.0	14.5	12.5	14.3	8.4	5.9	5.8
Polygonum amphibium	8.1	25.2	5.1	6.1	16.5	22.8	3.5	0.0	17.1	18.1	20.6	21.7
Coreopsis tinctoria	11.1	15.7	12.2	8.1	12.6	11.8	9.7	6.3	14.3	14.2	11.8	4.3

Appendix II. (cont.)

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Schedonnadrus paniculatus	28.3	9.0	16.3	23.2	6.3	6.3	22.1	0.0	20.0	5.2	11.8	5.8
Marsilea vestita	14.2	18.2	10.2	13.1	10.2	7.9	7.6	6.3	31.4	4.5	5.9	20.3
Polygonum lapathifolium	4.0	25.2	4.1	0.0	13.4	23.6	1.4	6.3	2.9	15.5	17.6	24.6
Ratibida tagetes	27.3	3.7	14.3	14.1	0.8	7.1	18.6	12.5	20.0	3.2	0.0	1.5
Sagittaria longiloba	7.1	16.4	4.1	8.1	5.5	17.3	2.8	6.3	20.0	0.0	17.6	18.8
Xanthium strumarium	10.1	15.7	5.1	6.1	8.7	7.9	4.8	6.3	8.6	10.3	5.9	5.8
Vernonia marginata	17.2	9.7	2.01	7.2	6.3	4.7	11.0	12.5	17.1	6.5	5.9	2.9
Portulaca oleracea	25.2	5.2	7.21	9.2	2.4	3.9	11.7	31.3	14.3	1.9	2.9	7.3
Opuntia phaeacantha	28.3	0.0	20.4	20.2	0.0	0.0	26.9	0.0	2.9	0.0	0.0	0.0
Bromus unioloides	8.1	17.2	7.21	0.0	17.3	1.6	4.2	6.3	5.7	9.7	14.7	5.8
Euphorbia marginata	15.1	8.2	1.01	5.2	3.2	7.9	10.3	6.3	0.0	7.1	2.9	2.9
Suckleya suckleyana	8.1	14.2	3.1	7.1	6.3	11.0	5.5	6.3	2.9	10.3	11.8	8.7
Scirpus validus	2.0	18.6	1.02	0.0	11.8	18.9	2.1	0.0	0.0	12.9	14.7	20.3
Hoffmannseggia glauca	17.2	3.7	14.3	13.1	0.8	0.8	10.3	43.8	14.3	1.9	0.0	1.5
Typha domingensis	1.0	18.6	0.0	1.1	11.8	18.1	0.7	0.0	0.0	6.5	20.6	15.9
Tragopogon dubius	11.1	9.8	10.2	1.0	7.9	3.9	6.9	0.0	2.9	8.4	2.9	1.5
Cyperus esculentus	6.1	14.2	0.0	6.1	5.5	11.1	2.8	6.3	2.9	7.7	5.9	10.1
Lepidium densiflorum	13.1	7.5	13.3	0.0	7.9	0.0	6.2	6.3	8.6	6.5	0.0	0.0
Rumex altissimus	5.1	12.7	2.0	4.0	7.1	12.6	2.1	0.0	8.6	9.0	2.9	14.5
Cuscuta squamata	6.1	10.4	3.1	7.1	0.8	10.2	4.8	6.3	5.7	8.4	0.0	1.5
Leptochloa fascicularis	7.1	11.9	0.0	7.1	0.0	12.6	2.7	0.0	8.7	5.8	2.9	8.7
Phalaris caroliniana	2.0	13.4	2.0	0.0	14.2	0.0	0.7	0.0	2.9	6.5	11.8	5.8
Panicum capillare	11.1	6.8	0.0	11.1	1.6	5.5	7.6	0.0	0.0	4.5	2.9	1.5
Helenium microcephalum	8.1	8.9	8.2	6.1	6.3	7.1	6.9	0.0	11.4	5.2	11.8	7.3
Proboscidea louisianica	7.1	8.2	0.0	7.1	1.6	7.1	4.1	0.0	2.9	3.9	2.9	5.8
Nothoscordum bivalve	8.1	7.5	9.2	0.0	6.3	0.8	2.7	12.5	8.6	2.9	2.9	5.8
Salix nigra	0.0	13.4	0.0	0.0	7.9	11.0	0.0	0.0	0.0	12.3	5.9	4.4
Heteranthera limosa	2.0	11.2	0.0	3.0	0.8	8.7	0.0	6.3	5.7	1.9	5.9	13.0
Haplopappus ciliatus	7.1	6.0	4.1	5.1	1.6	4.7	4.1	0.0	2.9	2.6	2.9	4.4
Sitanion hystrix	13.1	2.2	13.3	4.1	1.6	0.8	11.0	0.0	2.9	1.3	2.9	0.0
Ratibida columnifera	12.1	3.0	6.3	7.7	0.8	2.4	6.9	12.5	0.0	2.6	0.0	0.0
Melilotus officinalis	10.1	2.2	8.2	6.1	1.6	0.8	9.0	0.0	2.9	0.7	2.9	1.5
Sisymbrium altissimum	5.1	6.0	6.3	0.0	5.5	0.0	4.1	0.0	0.0	3.9	2.9	0.0
Quincula lobata	5.1	5.2	4.1	2.0	5.5	0.0	4.1	0.0	0.0	1.3	0.0	7.3
Aristida purpurea	13.1	0.0	11.2	6.1	0.0	0.0	11.0	6.3	0.0	0.0	0.0	0.0
Ambrosia psilostachya	8.1	3.0	6.3	4.0	0.8	3.2	6.2	6.3	2.9	1.9	0.0	1.5
Sphaeralcea coccinea	10.1	0.7	10.2	2.0	0.8	0.0	4.6	6.3	0.0	0.7	0.0	0.0

Appendix II. (cont.)

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Ammannia auriculata	3.0	7.5	0.0	4.0	0.8	6.3	0.7	0.0	8.6	3.2	0.0	5.8
Cynodon dactylon	2.0	6.0	2.0	1.0	3.9	4.7	0.7	6.3	2.9	5.2	8.8	0.0
Sophora nuttalliana	6.1	2.2	5.1	3.0	1.6	0.8	5.5	0.0	0.0	1.3	0.0	1.5
Descurainia pinnata	2.0	7.5	2.0	0.0	5.5	0.8	1.4	0.0	0.0	4.5	2.9	2.9
Sporobolus cryptandrus	4.0	4.5	3.1	3.0	1.6	4.7	4.1	0.0	0.0	3.2	0.0	1.5
Euphorbia albomarginata	7.1	0.7	0.0	7.1	0.0	0.8	3.5	12.5	0.0	0.7	0.0	0.0
Chloris verticillata	6.1	1.5	4.1	2.0	0.8	0.8	4.1	0.0	0.0	1.3	0.0	0.0
Astragalus mollissimus	9.1	0.7	8.2	1.0	0.0	0.8	5.5	6.3	0.0	0.7	0.0	0.0
Bromus japonicus	1.0	6.0	1.0	0.0	6.3	0.0	2.9	0.0	0.0	3.2	2.9	2.9
Picradeniopsis woodhousi	11.1	3.0	9.2	2.0	1.6	1.6	3.5	18.8	8.6	1.9	0.0	1.5
Machaeranthera tanacetifolia	4.0	2.2	3.1	2.0	2.4	0.0	2.8	6.3	0.0	0.0	5.9	2.9
Tamarix gallica	1.0	5.2	1.0	1.0	5.5	7.1	0.0	0.0	5.7	5.2	5.9	7.3
Gutierrezia sarothrae	7.1	0.0	3.1	6.1	0.0	0.0	5.5	0.0	2.9	0.0	0.0	0.0
Prosopis glandulosa	5.1	0.7	4.1	3.0	0.8	0.8	4.8	0.0	0.0	1.3	0.0	0.0
Opuntia imbricata	7.1	0.0	5.1	5.1	0.0	0.0	6.2	0.0	2.9	0.0	0.0	0.0
Croton dioicus	5.1	0.0	4.1	3.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0
Convolvulus equitans	3.0	2.2	3.1	0.0	2.4	0.8	0.7	0.0	5.7	1.3	2.9	1.5
Portulaca mundula	6.1	0.0	2.0	5.1	0.0	0.0	4.1	0.0	2.9	0.0	0.0	0.0
Bothriochloa laguroides	5.1	0.7	3.1	1.0	0.8	1.6	4.1	0.0	0.0	0.0	0.0	0.0
Heterotheca latifolia	1.0	4.5	1.0	0.0	3.2	0.8	0.0	3.6	0.0	2.6	5.9	1.5
Mimosa borealis	6.1	0.0	4.1	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0
Helianthus petiolaris	2.0	3.0	2.0	0.0	3.2	0.0	0.7	0.0	2.9	1.3	2.9	1.5
Hordeum jubatum	1.0	2.2	0.0	0.0	1.6	1.6	0.0	0.0	0.0	1.3	2.9	1.5
Plantago patagonica	5.0	0.0	0.0	5.1	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0
Hymenoxys odorata	7.1	0.7	7.1	1.1	0.8	0.0	3.5	12.5	2.9	0.7	0.0	0.0
Ulmus pumila	0.0	3.0	0.0	0.0	2.4	3.2	0.0	0.0	0.0	3.9	2.9	0.0
Populus deltoides	1.0	3.0	0.0	1.0	2.4	2.4	0.7	0.0	0.0	2.6	2.9	1.5
Panicum dichotomiflorum	0.0	3.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.7	5.9	1.5
Sagittaria calycina	1.0	2.2	0.0	1.0	0.0	2.4	0.7	0.0	0.0	0.7	0.0	2.9
Tridens albescens	0.0	1.5	1.0	3.0	0.8	0.0	2.1	6.3	0.0	0.7	0.0	0.0
Polygonum aviculare	0.0	3.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	1.9	2.9	0.0
Physalis viscosa	4.0	0.7	4.1	0.0	0.8	0.0	1.4	12.5	0.0	0.7	0.0	0.0
Lesquerella gordonii	4.0	0.0	4.1	0.0	0.0	0.0	2.1	0.0	2.9	0.0	0.0	0.0
Erodium cicutarium	4.0	0.7	3.1	0.0	0.8	0.0	1.4	6.3	0.0	0.7	0.0	0.0
Gaura coccinea	3.0	0.7	3.1	0.0	0.8	0.0	1.4	0.0	2.9	0.7	0.0	0.0
Scirpus acutus	0.0	3.0	0.0	0.0	0.8	2.4	0.0	0.0	0.0	0.0	2.9	4.4

Appendix II. (cont.)

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Ammannia coccinea	0.0	3.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	5.8
Bacopa rotundifolia	0.0	2.2	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.7	0.0	2.9
Gutierrezia dracunculoides	3.3	0.0	0.0	3.0	0.0	0.0	1.4	0.0	2.9	0.0	0.0	0.0
Elymus canadensis	2.0	0.7	1.0	2.0	0.8	0.0	1.4	0.0	2.9	0.7	0.0	0.0
Bouteloua gracilis	3.0	0.0	1.0	1.0	0.0	0.8	1.4	0.0	0.0	0.0	2.9	0.0
Cirsium undulatum	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Euphorbia dentata	3.0	0.0	1.0	2.0	0.0	0.0	0.7	6.3	2.9	0.0	0.0	0.0
Xanthisma texanum	2.0	0.7	2.0	0.0	0.8	0.0	0.7	6.3	0.0	0.0	0.0	1.5
Senecio douglassii	3.0	0.7	1.0	2.0	0.8	0.0	2.1	0.0	0.0	0.0	2.9	0.0
Potamogeton nodosus	0.0	2.2	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	2.9	2.9
Echinodorus rostratus	0.0	3.0	0.0	1.0	0.0	2.4	0.0	0.0	2.9	0.7	0.0	2.9
Eleocharis parvula	0.0	2.2	3.1	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0
Salix amygdaloides	0.0	2.2	0.0	0.0	1.6	2.4	0.0	0.0	0.0	2.6	2.9	0.0
Salix exigua	1.0	1.5	1.0	1.0	1.6	1.6	1.4	0.0	0.0	1.9	2.9	0.0
Allium drummondii	3.0	0.0	3.1	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0
Heteranthera mexicana	0.0	2.2	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	2.9	2.9
Desmanthus illinoensis	1.0	0.7	0.0	1.0	0.0	0.8	0.7	0.0	0.0	0.0	0.0	1.5
Sphaeralcea hastulata	2.0	0.0	0.0	2.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Scirpus maritimus	1.0	0.7	1.0	1.0	0.8	0.8	0.0	0.0	5.7	1.3	0.0	0.0
Asclepias verticillata	1.0	0.7	0.0	1.0	0.0	0.8	0.7	0.0	0.0	0.7	0.0	0.0
Setaria glauca	1.0	0.7	0.0	0.0	0.0	1.6	0.0	0.0	0.0	1.3	0.0	0.0
Gaura villosa	0.0	0.7	0.0	0.0	0.8	0.8	0.0	0.0	0.7	2.9	0.0	0.0
Sporobolus airoides	0.0	0.7	1.0	0.0	0.8	0.0	0.7	0.0	0.0	2.9	0.0	0.0
Potamogeton pectinatus	1.0	0.7	1.0	0.0	0.0	0.8	0.7	0.0	0.0	0.0	0.0	1.5
Echinocactus texensis	2.0	0.0	2.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Typha latifolia	0.0	1.5	0.0	0.0	0.8	1.4	0.0	0.0	0.0	0.0	2.9	4.4
Lippia cuneifolia	2.0	0.0	2.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Engelmannia pinnatifida	2.0	0.0	0.0	2.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Evolvulus nuttallianus	1.0	0.0	2.0	0.0	0.0	0.0	0.7	6.3	0.0	0.0	0.0	0.0
Gaura angustifolia	2.0	0.0	2.0	0.0	0.0	0.0	0.7	6.3	0.0	0.0	0.0	0.0
Linum pratense	2.0	0.0	2.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0
Scirpus americanus	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.7	0.0	0.0
Polypogon monspeliensis	0.0	1.5	0.0	0.0	1.6	1.6	0.0	0.0	0.0	0.7	0.0	1.5
Asclepias engelmanniana	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Iva axillaris	2.0	0.0	2.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Potentilla rivalis	0.0	0.7	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Scirpus saximontanus	2.0	0.7	0.0	2.0	0.0	0.8	0.0	12.5	0.0	0.0	0.0	1.5

Appendix II. (cont.)

Species	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Thelesperma simplifaluim	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Erysimum asperum	1.0	0.7	1.0	0.0	0.0	0.8	0.7	0.0	0.0	0.7	0.0	0.0
Amaranthus palmeri	2.0	0.0	1.0	1.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Eleocharis atropurpurea	3.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	8.6	0.0	0.0	0.0
Aristida pansa	2.0	0.0	0.0	2.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Dyssodia acerosa	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Dyssodia papposa	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Asclepias latifolia	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Muhlenbergia porteri	1.0	0.0	0.0	0.0	0.8	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Andropogon barbinodis	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Munroa squarrosa	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Tribulus terrestris	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.7	0.0	0.0
Eragrostis curtipedicellata	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.7	0.0	0.0
Panicum coloratum	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Lemna spp.	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.5
Mentzelia nuda	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Sisyrinchium spp.	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.5
Antennaria parvifolia	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.7	0.0	0.0
Ruppia maritima	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0
Eragrostis pectinacea	1.0	0.0	1.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0
Alopecurus carolinianus	1.0	0.0	1.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0
Achillea millefolium	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Convolvulus arvensis	1.0	0.0	2.0	1.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0
Erodium texanum	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Gaillardia pulchella	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Hilaria jamesii	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Setaria viridis	1.0	0.7	1.0	3.0	0.8	0.0	2.8	0.0	0.0	0.7	0.0	0.0
Andropogon scoparius	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Machaeranthera bigelorvii	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Muhlenbergia repens	1.0	0.0	1.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0
Bothriochloa ischaemum	1.0	0.0	1.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	2.9	0.0
Najas guadalupensis	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.5
Artemisia filifolia	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Senecio longilobus	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Senecio ampullaceus	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Setaria verticillata	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Bouteloua curtipendula	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0

Appendix II. (cont.)

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Capsella bursa-pastoris	0.0	0.7	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Sonchus asper	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.7	0.0	0.0
Dimorphocarpa palmeri	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Sphaeralcea angustifolia	2.0	0.0	2.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Panicum virgatum	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Festuca arundinacea	0.0	0.7	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Thelesperma megapotamicum	2.0	0.0	2.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Eragrostis cilianensis	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Eragrostis curvula	0.0	0.7	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Amaranthus spinosus	0.0	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.7	0.0	0.0
Descurainia richardsonii	1.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Cucurbita foetidissima	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Melilotus alba	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Andropogon ischaemum	1.0	0.7	0.0	1.0	0.8	0.0	0.7	0.0	0.0	0.0	0.0	1.5
Festuca pratensis	1.0	0.0	0.0	1.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Polygonum argyrocoleon	0.0	0.7	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Mimosa strigalosa	1.0	0.0	2.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0

[a]Sample sizes for calculation of frequency of occurrence were: Overall Grassland = 99, Cropland = 134; Seasonal Grassland Early = 98, Late = 99; Seasonal Cropland Early = 127, Late = 127; Soil Moisture Grassland Dry = 145, Moist = 16, Flooded = 35; Soil Moisture Cropland Dry = 155, Moist = 34, Flooded = 69.

APPENDIX III

Percent plant community composition across (overall) and within 2 sampling periods (early and late season) as well as for 3 soil moisture regimes (dry, moist, flooded) by watershed type (cropland n = *134; grassland* n = *99 playas) in 233 playa wetlands of 40 counties in the Playa Lakes Region of Texas, New Mexico, Oklahoma, Colorado, and Kansas during 1995.*

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Ambrosia grayi	12.98	15.38	11.73	14.66	13.94	16.76	14.82	8.33	8.59	19.54	17.96	7.10
Eleocharis macrostachya	17.70	10.96	20.62	15.08	11.65	10.29	12.48	31.04	29.74	6.74	15.02	16.64
Malvella leprosa	6.01	3.96	6.89	5.89	4.50	3.43	7.35	8.39	1.48	6.05	2.98	0.77
Helianthus ciliaris	2.63	1.36	2.94	2.37	1.59	1.14	3.16	2.71	1.02	1.87	0.80	0.74
Oenothera canescens	1.37	1.02	1.62	1.14	1.36	0.70	1.72	1.87	0.22	1.58	0.62	0.22
Kochia scoparia	2.93	5.49	2.48	3.49	4.58	6.38	4.09	0.13	0.19	8.61	3.18	1.12
Polygonum pensylvanicum	1.28	5.21	1.16	1.45	3.22	7.14	0.93	0.54	2.49	6.07	5.93	3.44
Buchloë dactyloides	9.12	1.50	11.13	7.25	1.99	1.03	10.95	11.92	3.06	2.01	1.42	0.67
Chenopodium leptophyllum	1.39	1.25	1.56	1.24	1.42	1.08	1.84	1.30	0.08	1.95	0.78	0.24
Chenopodium album	0.38	1.12	0.30	0.47	1.03	1.21	0.52	0.03	0.03	1.64	0.76	0.38
Echinochloa crusgalli	1.32	3.30	0.08	2.67	0.51	6.01	1.54	1.33	0.67	3.93	3.74	2.04
Rorippa sinuata	0.21	0.63	0.33	0.10	1.10	0.16	0.20	0.15	0.25	0.62	0.79	0.57
Lippia nodiflora	1.93	0.24	1.92	2.00	0.30	0.19	2.34	2.12	0.67	0.36	0.01	0.14
Rumex crispus	0.12	1.84	0.13	0.11	2.01	1.68	0.06	0.26	0.26	1.79	3.09	1.40
Solanum elaeagnifolium	0.39	01.0	0.44	0.34	0.09	0.11	0.37	0.64	0.39	0.16	0.01	0.03
Agropyron smithii	7.87	1.36	8.51	7.41	1.60	1.13	9.01	1.79	5.93	1.06	1.17	1.99
Hordeum pusillum	0.47	0.42	0.93	0.00	0.85	0.00	0.62	0.18	0.11	0.68	0.24	0.06
Amaranthus retroflexus	0.22	0.63	0.15	0.30	0.50	0.76	0.30	0.13	0.00	0.77	1.09	0.19
Grindelia squarrosa	0.51	0.27	0.41	0.64	0.30	0.24	0.47	2.28	0.21	0.30	0.15	0.27
Helianthus annuus	0.13	0.66	0.13	0.14	0.16	1.15	0.14	0.41	0.04	0.97	0.16	0.34
Aster subulatus	0.39	1.29	0.42	0.37	0.72	1.85	0.37	0.00	0.55	1.00	3.14	1.00
Panicum obtusum	0.98	0.36	0.84	1.14	0.66	0.07	1.20	2.20	0.01	0.51	0.49	0.04
Conyza canadensis	0.05	0.39	0.05	0.06	0.43	0.35	0.04	0.10	0.07	0.62	0.28	0.04
Verbena bracteata	0.22	0.09	0.16	0.25	0.09	0.09	0.24	0.41	0.10	0.13	0.09	0.03
Sorghum halepense	0.33	0.70	0.19	0.47	0.49	0.91	0.32	0.00	0.00	0.95	0.49	0.37
Polygonum ramosissimum	0.08	0.16	0.02	0.14	0.19	0.14	0.06	0.00	0.16	0.17	0.20	0.14
Paspalum paspalodes	0.78	2.31	0.35	1.26	1.74	2.86	0.39	0.13	2.09	1.49	7.53	1.45
Lythrum californicum	0.45	0.18	0.21	0.73	0.13	0.22	0.50	0.69	0.26	0.10	0.80	0.05
Salsola iberica	0.06	0.13	0.05	0.09	0.03	0.22	0.09	0.05	0.006	0.22	0.007	0.02
Lactuca serriola	0.13	0.14	0.24	0.02	0.11	0.16	0.19	0.00	0.00	0.18	0.22	0.02
Solanum rostratum	0.11	0.14	0.01	0.21	0.01	0.27	0.14	0.10	0.01	0.04	0.86	0.006
Polygonum amphibium	1.37	2.79	0.83	1.98	2.31	3.25	0.16	0.00	5.23	1.45	2.94	4.14
Coreopsis tinctoria	0.28	0.68	0.21	0.35	0.97	0.41	0.37	0.00	0.07	1.09	0.23	0.19

Appendix III. (cont.)

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Schedonnadrus paniculatus	0.35	0.05	0.29	0.41	0.03	0.08	0.46	0.00	0.10	0.07	0.08	0.02
Marsilea vestita	0.38	0.24	0.08	0.71	0.30	0.18	0.43	0.15	0.30	0.09	0.01	0.59
Polygonum lapathifolium	0.04	1.51	0.07	0.00	0.96	2.05	0.02	0.05	0.08	2.19	0.75	0.68
Ratibida tagetes	0.46	0.01	0.49	0.44	0.00	0.03	0.63	0.08	0.02	0.02	0.00	0.006
Sagittaria longiloba	0.54	0.63	0.32	0.79	0.08	1.16	0.63	0.18	0,36	0.24	0.81	1.24
Xanthium strumarium	0.02	0.02	0.003	0.04	0.006	0.04	0.02	0.05	0.03	0.03	0.01	0.006
Vernonia marginata	0.09	0.02	0.05	0.13	0.03	0.01	0.07	0.18	0.13	0.04	0.01	0.00
Portulaca oleracea	0.16	0.16	0.04	0.30	0.006	0.32	0.17	0.54	0.07	0.11	0.73	0.01
Opuntia phaeacantha	0.09	0.00	0.06	0.11	0.00	0.00	0.11	0.00	0.02	0.00	0.00	0.00
Bromus unioloides	0.08	0.40	0.16	0.003	0.70	0.11	0.05	0.77	0.02	0.55	0.03	0.30
Euphorbia marginata	0.06	0.03	0.006	0.13	0.01	0.04	0.09	0.00	0.00	0.03	0.06	0.00
Suckleya suckleyana	0.25	0.83	0.10	0.42	0.37	1.27	0.27	0.00	0.26	1.12	0.68	0.40
Scirpus validus	0.00	1.62	0.00	0.00	1.17	2.06	0.00	0.00	0.00	1.06	2.72	2.12
Hoffmannseggia glauca	0.12	0.03	0.15	0.09	0.04	0.04	0.09	0.66	0.08	0.05	0.00	0.003
Typha domingensis	0.00	2.40	0.00	0.00	2.32	2.47	0.00	0.00	0.00	2.38	2.63	2.36
Tragopogon dubius	0.03	0.01	0.05	0.009	0.01	0.01	0.04	0.00	0.00	0.02	0.00	0.00
Cyperus esculentus	0.01	0.05	0.00	0.02	0.03	0.06	0.01	0.00	0.00	0.07	0.00	0.03
Lepidium densiflorum	0.06	0.04	0.12	0.00	0.08	0.00	0.08	0.00	0.04	0.07	0.00	0.00
Rumex altissimus	0.03	0.53	0.02	0.03	0.54	0.52	0.02	0.00	0.04	0.68	0.34	0.34
Cuscuta squamata	0.03	0.04	0.00	0.07	0.00	0.08	0.04	0.00	0.006	0.08	0.00	0.00
Leptochloa fascicularis	0.04	0.02	0.00	0.08	0.00	0.05	0.05	0.00	0.00	0.03	0.00	0.03
Phalaris caroliniana	0.11	0.65	0.21	0.00	1.32	0.00	0.15	0.00	0.00	0.43	2.07	0.42
Panicum capillare	0.08	0.02	0.00	0.16	0.00	0.05	0.11	0.00	0.00	0.04	0.01	0.006
Helenium microcephalum	0.02	0.35	0.03	0.003	0.36	0.35	0.01	0.00	0.04	0.35	0.07	0.48
Proboscidea louisianica	0.006	0.01	0.00	0.01	0.002	0.02	0.006	0.00	0.006	0.01	0.007	0.006
Nothoscordum bivalve	0.01	0.01	0.02	0.00	0.02	0.00	0.006	0.00	0.02	0.02	0.00	0.01
Salix nigra	0.00	0.21	0.00	0.00	0.20	0.21	0.00	0.00	0.00	0.36	0.007	0.03
Heteranthera limosa	0.03	0.25	0.00	0.06	0.004	0.49	0.00	0.00	0.12	0.01	0.73	0.46
Haplopappus ciliatus	0.55	0.01	0.02	0.11	0.002	0.02	0.08	0.00	0.02	0.02	0.01	0.00
Sitanion hystrix	0.28	0.002	0.51	0.04	0.004	0.00	0.39	0.00	0.00	0.004	0.00	0.00
Ratibida columnifera	0.05	0.004	0.05	0.05	0.00	0.008	0.06	0.08	0.00	0.007	0.00	0.00
Melilotus officinalis	0.20	0.00	0.25	0.15	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00
Sisymbrium altissimum	0.02	0.02	0.04	0.00	0.05	0.00	0.03	0.00	0.00	0.007	0.14	0.00
Quincula lobata	0.01	0.005	0.02	0.009	0.01	0.00	0.02	0.00	0.00	0.007	0.00	0.01
Aristida purpurea	0.31	0.00	0.56	0.06	0.00	0.00	0.44	0.03	0.00	0.00	0.00	0.00
Ambrosia psilostachya	0.11	0.003	0.10	0.12	0.00	0.006	0.15	0.03	0.00	0.005	0.00	0.00
Sphaeralcea coccinea	0.03	0.00	0.06	0.006	0.00	0.00	0.04	0.03	0.00	0.00	0.00	0.00

Appendix III. (cont.)

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Ammannia auriculata	0.03	0.01	0.00	0.006	0.004	0.02	0.00	0.00	0.01	0.02	0.00	0.01
Cynodon dactylon	0.00	0.13	0.00	0.00	0.07	0.18	0.00	0.00	0.00	0.22	0.04	0.003
Sophora nuttalliana	0.04	0.02	0.07	0.01	0.04	0.004	0.06	0.00	0.00	0.04	0.00	0.00
Descurainia pinnata	0.01	0.003	0.03	0.00	0.006	0.00	0.002	0.21	0.00	0.005	0.00	0.00
Sporobolus cryptandrus	0.56	0.009	0.64	0.48	0.006	0.01	0.79	0.00	0.00	0.02	0.00	0.00
Euphorbia albomarginata	0.006	0.006	0.00	0.01	0.00	0.01	0.006	0.03	0.00	0.01	0.00	0.00
Chloris verticillata	0.04	0.009	0.06	0.02	0.01	0.004	0.06	0.00	0.00	0.02	0.00	0.00
Astragalus mollissimus	0.003	0.00	0.003	0.003	0.00	0.00	0.002	0.03	0.00	0.00	0.00	0.00
Bromus japonicus	0.02	0.06	0.04	0.00	0.12	0.00	0.03	0.00	0.00	0.11	0.00	0.01
Picradeniopsis woodhousi	0.31	0.006	0.58	0.02	0.01	0.00	0.22	1.38	0.29	0.01	0.00	0.00
Machaeranthera tanacetifolia	0.003	0.005	0.06	0.00	0.01	0.00	0.04	0.00	0.12	0.009	0.00	0.00
Tamarix gallica	0.02	0.04	0.03	0.00	0.04	0.05	0.00	0.00	0.07	0.05	0.06	0.03
Gutierrezia sarothrae	0.07	0.00	0.009	0.14	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
Prosopis glandulosa	0.009	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Opuntia imbricata	0.02	0.00	0.009	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Croton dioicus	0.04	0.00	0.07	0.02	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Convolvulus equitans	0.00	0.01	0.00	0.00	0.02	0.004	0.00	0.00	0.00	0.007	0.05	0.00
Portulaca mundula	0.006	0.00	0.00	0.01	0.00	0.00	0.008	0.00	0.00	0.00	0.00	0.00
Bothriochloa laguroides	0.03	0.00	0.01	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Heterotheca latifolia	0.006	0.007	0.01	0.00	0.008	0.006	0.00	0.10	0.00	0.01	0.00	0.00
Helianthus petiolaris	0.003	0.009	0.006	0.00	0.02	0.00	0.004	0.00	0.00	0.01	0.00	0.01
Hordeum jubatum	0.00	0.19	0.00	0.00	0.39	0.01	0.00	0.00	0.00	0.29	0.04	0.09
Plantago patagonica	0.02	0.00	0.00	0.04	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Hymenoxys odorata	0.03	0.002	0.05	0.00	0.004	0.00	0.00	0.46	0.006	0.004	0.00	0.00
Populus deltoides	0.00	0.001	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.002	0.00	0.00
Panicum dichotomiflorum	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.08	0.003
Sagittaria calycina	0.05	0.005	0.00	0.10	0.00	0.01	0.07	0.00	0.00	0.00	0.00	0.02
Tridens albescens	0.01	0.00	0.003	0.02	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00
Physalis viscosa	0.009	0.00	0.02	0.00	0.00	0.00	0.008	0.05	0.00	0.00	0.00	0.00
Lesquerella gordonii	0.003	0.00	0.006	0.00	0.00	0.00	0.002	0.00	0.006	0.00	0.00	0.00
Erodium cicutarium	0.003	0.001	0.006	0.00	0.002	0.00	0.00	0.05	0.00	0.002	0.00	0.00
Gaura coccinea	0.02	0.00	0.03	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Bacopa rotundifolia	0.00	0.003	0.00	0.00	0.00	0.006	0.00	0.00	0.00	0.002	0.00	0.006
Gutierrezia dracunculoides	0.004	0.00	0.00	0.009	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.00
Elymus canadensis	0.00	0.009	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Bouteloua gracilis	0.009	0.00	0.003	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Cirsium undulatum	0.006	0.00	0.01	0.00	0.00	0.00	0.008	0.00	0.00	0.00	0.00	0.00

Appendix III. (cont.)

Species	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Euphorbia dentata	0.006	0.00	0.00	0.01	0.00	0.00	0.002	0.00	0.02	0.00	0.00	0.00
Senecio douglassii	0.007	0.00	0.006	0.009	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Potamogeton nodosus	0.00	0.12	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.40
Echinodorus rostratus	0.00	0.05	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.16
Eleocharis parvula	0.05	0.00	0.10	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Salix amygdaloides	0.00	0.06	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.11	0.00	0.00
Salix exigua	0.01	0.03	0.00	0.03	0.02	0.04	0.02	0.00	0.00	0.06	0.00	0.00
Desmanthus illinoensis	0.003	0.001	0.00	0.006	0.00	0.002	0.004	0.00	0.00	0.00	0.00	0.003
Sphaeralcea hastulata	0.01	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Scirpus maritimus	0.01	0.04	0.02	0.003	0.04	0.03	0.00	0.00	0.05	0.06	0.00	0.00
Asclepias verticillata	0.00	0.001	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.002	0.00	0.00
Setaria glauca	0.00	0.002	0.00	0.00	0.00	0.004	0.00	0.00	0.00	0.004	0.00	0.00
Gaura villosa	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.007	0.00
Sporobolus airoides	0.00	0.02	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.004	0.00	0.00
Potamogeton pectinatus	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.04
Echinocactus texensis	0.001	0.00	0.003	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.00
Evolvulus nuttallianus	0.02	0.00	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Linum pratense	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00
Scirpus americanus	0.00	0.001	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.002	0.00	0.00
Polypogon monspeliensis	0.00	0.04	0.00	0.00	0.07	0.02	0.00	0.00	0.00	0.08	0.00	0.00
Iva axillaris	0.30	0.00	0.59	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00
Potentilla rivalis	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Scirpus saximontanus	0.00	0.003	0.00	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.00	0.01
Erysimum asperum	0.00	0.001	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.002	0.00	0.00
Aristida pansa	0.003	0.00	0.00	0.006	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00
Dyssodia acerosa	0.006	0.00	0.01	0.00	0.00	0.00	0.008	0.00	0.00	0.00	0.00	0.00
Dyssodia papposa	0.03	0.00	0.07	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
Muhlenbergia porteri	0.003	0.00	0.00	0.006	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00
Andropogon barbinodis	0.003	0.00	0.00	0.006	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00
Tribulus terrestris	0.00	0.001	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.002	0.00	0.00
Mentzelia nuda	0.001	0.00	0.00	0.003	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.00
Antennaria parvifolia	0.00	0.001	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.002	0.00	0.00
Ruppia maritima	0.50	0.00	0.00	1.05	0.00	0.00	0.00	0.00	2.10	0.00	0.00	0.00
Convolvulus arvensis	0.003	0.00	0.00	0.006	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00
Gaillardia pulchella	0.001	0.00	0.003	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.00
Hilaria jamesii	0.001	0.00	0.00	0.003	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.00
Setaria viridis	0.05	0.001	0.00	0.11	0.002	0.00	0.07	0.00	0.00	0.002	0.00	0.00

Appendix III. (cont.)

	Overall		Seasonal				Soil Moisture					
			Grassland		Cropland		Grassland			Cropland		
Species	Grassland	Cropland	Early	Late	Early	Late	Dry	Moist	Flooded	Dry	Moist	Flooded
Bothriochloa ischaemum	0.003	0.00	0.006	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Najas guadalupensis	0.00	0.03	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.11
Senecio longilobus	0.001	0.00	0.003	0.00	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.00
Senecio ampullaceus	0.004	0.00	0.009	0.00	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.00
Capsella bursa-pastoris	0.00	0.007	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Sphaeralcea angustifolia	0.003	0.00	0.006	0.00	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00
Panicum virgatum	0.003	0.00	0.006	0.00	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00
Thelesperma megapotamicum	0.007	0.00	0.01	0.00	0.00	0.00	0.002	0.10	0.00	0.00	0.00	0.00
Eragrostis curvula	0.00	0.001	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.002	0.00	0.00
Andropogon ischaemum	0.08	0.00	0.00	0.16	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00
Ulmus pumila	0.00	0.003	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.005	0.00	0.00
Dead Vegetation	6.15	5.50	2.44	7.45	5.77	5.24	7.53	6.01	2.52	5.41	6.90	5.09
Soil/Water	12.97	17.22	14.57	11.63	23.95	10.71	7.91	7.44	29.03	8.51	3.73	38.62

APPENDIX IV

Frequency of occurrence (%) and percent community composition of 178 common (>5% frequency) plant species occurring along step-point transects in 233 playa wetlands in 40 counties in the Playa Lakes Region of Texas, New Mexico, Oklahoma, Colorado, and Kansas during 1995 separated into 6 groups[a] based on cluster analysis of scores from correspondence analysis.

	County Group											
	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6	
Species	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp
Ambrosia grayi	37.1	1.83	91.3	17.19	93.1	15.90	88.5	20.76	34.8	2.97	62.5	9.89
Eleocharis macrostachya	60.0	6.24	97.8	29.52	77.0	10.13	80.8	5.86	39.1	1.60	31.3	0.65
Malvella leprosa	68.6	8.25	63.0	1.80	85.1	6.88	84.6	2.61	52.2	3.67	18.8	2.69
Helianthus ciliaris	91.4	4.39	78.3	1.99	65.5	1.22	65.4	1.11	56.5	1.36	25.0	1.54
Oenothera canescens	57.1	1.52	67.4	0.84	79.3	1.43	84.6	1.27	30.4	0.34	56.3	0.77
Kochia scoparia	34.3	0.88	50.0	17.19	75.9	5.40	84.6	10.28	47.8	1.28	62.5	7.64
Polygonum pensylvanicum	11.4	0.21	52.2	4.94	74.7	3.84	69.2	2.51	60.9	5.64	18.8	0.06
Buchloë dactyloides	85.7	22.97	71.7	3.95	44.8	1.45	34.6	1.59	17.4	0.67	75.0	8.31
Chenopodium leptophyllum	34.3	0.47	50.0	1.46	66.7	1.54	53.8	0.36	43.5	0.38	31.3	2.04
Chenopodium album	20.0	0.24	45.7	0.24	65.5	1.27	88.5	1.81	30.4	0.73	37.5	0.58
Echinochloa crusgalli	22.9	0.91	54.3	1.72	64.4	3.33	61.5	2.78	65.2	4.38	0.0	0.00
Rorippa sinuata	11.4	0.06	60.9	0.35	60.9	0.51	73.1	1.30	4.4	0.00	18.8	0.16
Lippia nodiflora	54.3	2.88	67.4	0.98	27.6	0.08	38.5	0.14	17.4	0.07	87.5	4.69
Rumex crispus	5.7	0.13	39.1	0.63	54.0	0.91	80.8	3.70	34.8	2.68	6.3	0.00
Solanum elaeagnifolium	68.6	0.90	37.0	0.16	33.3	0.05	46.2	0.15	39.1	0.77	18.8	0.12
Agropyron smithii	11.4	0.50	80.4	6.34	13.8	0.17	30.8	1.23	0.0	0.00	100.0	31.10
Hordeum pusillum	22.9	1.09	63.0	0.67	21.8	0.27	19.2	0.18	26.1	0.62	37.5	0.27
Amaranthus retroflexus	31.4	0.68	15.2	0.02	35.6	0.51	46.2	0.82	30.4	1.43	6.3	0.00
Grindelia squarrosa	14.3	0.24	43.5	0.44	32.2	0.33	26.9	0.63	8.7	0.01	31.3	0.15
Helianthus annuus	0.0	0.00	13.0	0.07	33.3	0.54	46.2	1.59	39.1	0.10	56.3	0.40
Aster subulatus	8.6	0.32	39.1	1.37	32.2	0.64	15.4	0.50	39.1	2.79	6.3	0.01
Panicum obtusum	65.7	2.68	19.6	0.10	19.5	0.36	19.2	0.26	30.4	2.26	6.3	0.05
Conyza canadensis	11.4	0.03	32.6	0.07	18.4	0.007	26.9	0.45	52.2	2.08	31.3	0.06
Verbena bracteata	37.1	0.36	19.6	0.10	20.7	0.09	15.4	0.18	39.1	0.18	37.5	0.36
Sorghum halepense	2.9	0.10	6.5	0.01	23.0	0.27	57.7	1.11	52.2	4.37	6.3	0.00
Polygonum ramosissimum	17.1	0.20	32.6	0.14	23.0	0.18	3.9	0.00	26.1	0.35	12.5	0.03
Paspalum paspalodes	0.0	0.00	15.2	0.02	34.5	3.30	19.2	1.12	26.1	1.96	0.0	0.00
Lythrum californicum	2.9	0.01	45.7	0.47	16.1	0.06	7.7	0.03	8.7	0.00	50.0	1.88
Salsola iberica	31.4	0.35	8.7	0.02	18.4	0.11	15.4	0.03	21.7	0.09	43.8	0.06
Lactuca serriola	5.7	0.00	10.9	0.03	18.4	0.08	23.1	0.19	39.1	0.25	50.0	0.80
Solanum rostratum	14.3	0.08	28.3	0.36	20.7	0.04	11.5	0.01	4.4	0.01	12.5	0.02
Polygonum amphibium	2.9	0.01	21.7	4.56	23.0	1.57	26.9	0.54	17.4	2.27	0.0	0.00
Coreopsis tinctoria	0.0	0.00	17.4	0.05	26.4	1.20	23.1	0.18	4.4	0.64	0.0	0.00
Schedonnadrus paniculatus	5.7	0.03	41.3	0.24	6.9	0.08	0.0	0.00	4.4	0.02	62.5	1.04
Marsilea vestita	5.7	0.06	45.7	0.89	13.8	0.10	3.9	0.01	0.0	0.00	6.3	0.01
Polygonum lapathifolium	0.0	0.00	17.4	0.09	17.2	0.35	23.1	0.30	30.4	9.16	0.0	0.00
Ratibida tagetes	42.9	1.35	4.4	0.01	5.8	0.07	7.7	0.10	0.0	0.00	50.0	0.43
Sagittaria longiloba	0.0	0.00	32.6	1.13	14.9	0.66	7.7	0.05	4.4	0.10	0.0	0.00
Xanthium strumarium	0.0	0.00	8.7	0.01	12.6	0.01	19.2	0.17	39.1	0.11	12.5	0.00
Vernonia marginata	14.3	0.15	19.6	0.06	12.6	0.03	11.5	0.03	8.7	0.03	0.0	0.00
Portulaca oleracea	31.4	0.59	19.6	0.36	9.2	0.01	3.9	0.00	4.4	0.05	0.0	0.00
Opuntia phaeacantha	31.4	0.13	8.7	0.01	0.0	0.00	7.7	0.04	4.4	0.00	62.5	0.27
Bromus unioloides	5.7	0.90	13.0	0.05	9.2	0.04	11.5	0.02	34.8	1.58	6.3	0.04
Euphorbia marginata	11.4	0.02	17.4	0.07	9.2	0.03	3.9	0.01	0.0	0.00	37.5	0.07
Suckleya suckleyana	17.1	0.51	2.2	0.01	14.9	1.08	19.2	0.44	8.7	0.61	0.0	0.00
Scirpus validus	0.0	0.00	6.5	0.26	10.3	0.53	26.9	3.73	26.1	1.24	6.3	0.00
Hoffmannseggia glauca	34.3	0.37	8.7	0.05	3.4	0.01	0.0	0.00	21.7	0.08	12.5	0.04
Typha domingensis	0.0	0.00	6.5	0.58	10.3	0.71	30.8	6.33	21.7	1.70	0.0	0.00

Appendix IV. (cont.)

	County Group											
	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6	
Species	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp
Tragopogon dubius	5.7	0.01	4.4	0.01	5.7	0.00	3.9	0.01	30.4	0.07	50.0	0.12
Cyperus esculentus	5.7	0.00	8.7	0.02	12.6	0.03	15.4	0.10	13.0	0.02	0.0	0.00
Lepidium densiflorum	5.7	0.01	17.4	0.03	6.9	0.01	0.0	0.00	26.1	0.33	6.3	0.04
Rumex altissimus	0.0	0.00	10.9	0.23	11.5	0.40	19.2	0.90	4.4	0.07	0.0	0.00
Cuscuta squamata	5.7	0.03	2.2	0.00	14.9	0.04	11.5	0.01	0.0	0.00	6.3	0.16
Leptochloa fascicularis	0.0	0.00	21.7	0.05	8.1	0.03	7.7	0.00	8.7	0.04	6.3	0.00
Phalaris caroliniana	0.0	0.00	6.5	0.03	9.2	0.65	15.4	0.76	21.7	1.10	0.0	0.00
Panicum capillare	0.0	0.00	17.4	0.06	4.6	0.03	11.5	0.02	8.7	0.02	12.5	0.12
Helenium microcephalum	0.0	0.00	8.7	0.16	14.9	0.10	0.0	0.00	13.0	1.89	0.0	0.00
Proboscidea louisianica	14.3	0.02	4.4	0.01	6.9	0.01	7.7	0.01	8.7	0.01	6.3	0.00
Nothoscordum bivalve	5.7	0.00	17.4	0.03	5.7	0.00	0.0	0.00	13.0	0.01	0.0	0.00
Salix nigra	0.0	0.00	0.0	0.00	8.1	0.04	23.1	0.91	21.7	0.16	0.0	0.00
Heteranthera limosa	0.0	0.00	30.4	0.35	1.2	0.06	7.7	0.01	0.0	0.00	0.0	0.00
Haplopappus ciliatus	5.7	0.01	2.2	0.01	6.9	0.01	3.9	0.02	21.7	0.30	6.3	0.01
Sitanion hystrix	0.0	0.00	4.4	0.00	0.0	0.00	19.2	0.40	0.0	0.00	56.3	1.06
Ratibida columnifera	8.6	0.02	2.2	0.00	3.4	0.01	7.7	0.05	8.7	0.01	25.0	0.16
Melilotus officinalis	0.0	0.00	6.5	0.01	2.3	0.00	3.9	0.00	0.0	0.00	50.0	1.17
Sisymbrium altissimum	8.6	0.13	4.4	0.00	3.4	0.00	0.0	0.00	8.7	0.02	25.0	0.12
Quincula lobata	14.3	0.06	0.0	0.00	5.7	0.07	3.9	0.00	8.7	0.01	6.3	0.00
Aristida purpurea	2.9	0.01	2.2	0.00	0.0	0.00	3.9	0.00	0.0	0.00	62.5	1.40
Ambrosia psilostachya	11.4	0.04	2.2	0.00	2.3	0.00	11.5	0.24	4.4	0.00	12.5	0.24
Sphaeralcea coccinea	11.4	0.02	0.0	0.00	2.3	0.00	0.0	0.00	0.0	0.00	37.5	0.17
Ammannia auriculata	0.0	0.00	17.4	0.02	2.3	0.01	3.9	0.00	4.4	0.01	0.0	0.00
Cynodon dactylon	2.9	0.03	2.2	0.00	2.3	0.03	3.9	0.24	26.1	0.58	0.0	0.00
Sophora nuttalliana	2.9	0.00	2.2	0.02	1.2	0.00	7.7	0.02	17.4	0.24	18.8	0.06
Descurainia pinnata	2.9	0.00	0.0	0.00	3.4	0.00	3.9	0.01	26.1	0.07	0.0	0.00
Sporobolus cryptandrus	0.0	0.00	4.4	0.00	3.4	0.01	11.5	1.82	0.0	0.00	12.5	0.43
Euphorbia albomarginata	14.3	0.13	2.2	0.00	2.3	0.01	3.9	0.02	0.0	0.00	0.0	0.00
Chloris verticillata	5.7	0.05	0.0	0.00	4.6	0.03	3.9	0.01	0.0	0.00	12.5	0.12
Astragalus mollissimus	8.6	0.01	0.0	0.00	2.3	0.01	0.0	0.00	0.0	0.00	31.3	0.01
Bromus japonicus	0.0	0.00	6.5	0.06	4.6	0.05	3.9	0.01	0.0	0.00	6.3	0.12
Picradeniopsis woodhousi	14.3	0.45	2.2	0.06	2.3	0.00	3.9	0.03	0.0	0.00	0.0	0.00
Machaeranthera tanacetifolia	2.9	0.02	4.4	0.04	2.3	0.00	0.0	0.00	13.0	0.03	6.3	0.00
Tamarix gallica	0.0	0.00	0.0	0.00	1.2	0.00	7.7	0.08	17.4	0.28	0.0	0.00
Gutierrezia sarothrae	2.9	0.10	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	31.3	0.43
Prosopis glandulosa	8.6	0.04	2.2	0.00	1.2	0.00	0.0	0.00	8.7	0.00	0.0	0.00
Opuntia imbricata	14.3	0.07	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	12.5	0.00
Croton dioicus	17.1	0.19	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Convolvulus equitans	0.0	0.00	8.7	0.00	2.3	0.02	3.9	0.01	0.0	0.00	0.0	0.00
Portulaca mundula	11.4	0.03	4.4	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Bothriochloa laguroides	5.7	0.06	2.2	0.11	1.2	0.00	3.9	0.05	0.0	0.00	6.3	0.00
Heterotheca latifolia	2.9	0.00	0.0	0.00	0.0	0.00	0.0	0.00	21.7	0.09	0.0	0.00
Helianthus petiolaris	0.0	0.00	0.0	0.00	2.3	0.00	7.7	0.01	4.4	0.05	6.3	0.00
Mimosa borealis	5.7	0.00	4.4	0.00	0.0	0.00	0.0	0.00	4.4	0.00	6.3	0.00
Hordeum jubatum	0.0	0.00	4.4	0.06	1.2	0.25	0.0	0.00	0.0	0.00	12.5	0.31
Plantago patagonica	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	31.3	0.13
Hymenoxys odorata	17.1	0.12	0.0	0.00	0.0	0.00	3.9	0.01	4.4	0.02	0.0	0.00
Ulmus pumila	2.9	0.00	0.0	0.00	2.3	0.00	7.7	0.02	0.0	0.00	0.0	0.00
Populus deltoides	0.0	0.00	0.0	0.00	1.2	0.00	7.7	0.01	0.0	0.00	6.3	0.00
Panicum dichotomiflorum	0.0	0.00	6.5	0.02	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Sagittaria calycina	0.0	0.00	8.7	0.08	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Tridens albescens	8.6	0.06	0.0	0.00	0.0	0.00	3.9	0.00	0.0	0.00	0.0	0.00
Physalis viscosa	8.6	0.04	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Lesquerella gordonii	5.7	0.01	2.2	0.00	0.0	0.00	0.0	0.00	4.4	0.00	0.0	0.00

Appendix IV. (cont.)

	County Group											
	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6	
Species	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp
Erodium cicutarium	2.86	0.01	2.2	0.00	2.3	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Gaura coccinea	2.9	0.07	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.00	12.5	0.00
Bacopa rotundifolia	0.0	0.00	6.5	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Gutierrezia dracunculoides	5.7	0.02	2.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Elymus canadensis	0.0	0.00	0.0	0.00	1.2	0.01	0.0	0.00	0.0	0.00	12.5	0.00
Bouteloua gracilis	2.9	0.01	0.0	0.00	0.0	0.00	3.9	0.00	0.0	0.00	6.3	0.04
Cirsium undulatum	8.6	0.03	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.02	0.0	0.00
Euphorbia dentata	0.0	0.00	0.0	0.00	1.2	0.01	3.9	0.01	0.0	0.00	6.3	0.00
Senecio douglassii	2.8	0.01	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.00	6.3	0.03
Potamogeton nodosus	0.0	0.00	2.2	0.00	2.3	0.19	0.0	0.00	0.0	0.00	0.0	0.00
Xanthisma texanum	0.0	0.00	0.0	0.00	2.3	0.00	0.0	0.00	4.4	0.00	0.0	0.00
Echinodorus rostratus	0.0	0.00	4.4	0.04	1.2	0.03	0.0	0.00	0.0	0.00	0.0	0.00
Eleocharis parvula	0.0	0.00	6.5	0.07	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Salix amygdaloides	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	8.7	0.51	0.0	0.00
Salix exigua	0.0	0.00	0.0	0.00	1.2	0.01	3.9	0.01	4.4	0.27	0.0	0.00
Desmanthus illinoensis	0.0	0.00	2.2	0.00	0.0	0.00	3.9	0.01	0.0	0.00	0.0	0.00
Sphaeralcea hastulata	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.03	0.0	0.00	6.3	0.01
Scirpus maritimus	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.03	0.0	0.00	6.3	0.01
Asclepias verticillata	0.0	0.00	0.0	0.00	2.3	0.00	0.0	0.00	0.0	0.00	6.3	0.00
Scirpus maritimus	0.9	0.00	0.0	0.00	0.0	0.00	0.0	0.00	8.7	0.36	0.0	0.00
Setaria glauca	0.0	0.00	0.0	0.00	1.2	0.00	3.9	0.01	0.0	0.00	0.0	0.00
Gaura villosa	0.9	0.00	0.0	0.00	0.0	0.00	3.9	0.04	4.4	0.04	0.0	0.00
Sporobolus airoides	0.4	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.02	6.3	0.00
Potamogeton pectinatus	0.4	0.00	4.4	0.03	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Echinocactus texensis	5.7	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Evolvulus nuttallianus	5.7	0.09	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Engelmannia pinnatifida	0.0	0.00	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	6.3	0.00
Gaura angustifolia	5.7	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Linum pratense	5.7	0.08	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Scirpus americanus	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.01	6.3	0.00
Polypogon monspeliensis	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	8.7	0.00	0.0	0.00
Iva axillaris	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	12.5	1.84
Asclepias engelmanniana	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.3	0.00	0.0	0.00
Potentilla rivalis	2.9	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.12	0.0	0.00
Scirpus saximontanus	0.0	0.00	4.4	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Thelesperma simplifaluim	2.9	0.03	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.00
Erysimum asperum	2.9	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.00
Aristida pansa	5.7	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Dyssodia acerosa	2.9	0.03	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Dyssodia papposa	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.20
Muhlenbergia porteri	2.9	0.01	0.4	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Asclepias latifolia	2.9	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Andropogon barbinodis	2.9	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Tribulus terrestris	0.0	0.00	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Munroa squarrosa	2.9	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Mentzelia nuda	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.01
Eragrostis curtipedicellata	0.0	0.00	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Panicum coloratum	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.00	0.0	0.00
Lemna spp.	0.0	0.00	2.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Sisyrinchium spp.	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.01	0.0	0.00	0.0	0.00
Antennaria parvifolia	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.01	0.0	0.00
Ruppia maritima	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	2.87	0.0	0.00
Convolvulus arvensis	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.00

Appendix IV. (cont.)

	County Group											
	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6	
Species	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp	Occur	Comp
Eragrostis pectinacea	0.0	0.00	2.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Alopecurus carolinianus	0.0	0.00	2.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Achillea millefolium	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.00
Gaillardia pulchella	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.01
Hilaria jamesii	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.01
Setaria viridis	0.0	0.00	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Andropogon scoparius	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.01	0.0	0.00	0.0	0.00
Muhlenbergia repens	2.9	0.04	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Bothriochloa ischaemum	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.02	0.0	0.00
Najas guadalupensis	0.0	0.00	2.2	0.07	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Artemisia filifolia	2.9	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Senecio longilobus	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.01
Senecio ampullaceus	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.03
Setaria verticillata	0.0	0.00	2.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Bouteloua curtipendula	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.3	0.00
Capsella bursa-pastoris	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.06	0.0	0.00
Sonchus asper	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.01	4.4	0.00	0.0	0.00
Dimorphocarpa palmeri	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.00	0.0	0.00
Sphaeralcea angustifolia	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.01	0.0	0.00	0.0	0.00
Panicum virgatum	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.01	0.0	0.00	0.0	0.00
Thelesperma megapotamicum	2.9	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Eragrostis cilianensis	2.9	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Eragrostis curvula	0.0	0.00	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Festuca pratensis	0.0	0.00	0.0	0.00	1.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Dead Vegetation	74.3	13.37	52.2	1.98	74.7	5.98	76.9	7.53	82.6	8.04	68.8	4.98
Soil/Water	97.1	16.24	84.8	8.66	93.1	23.18	84.6	6.10	82.6	19.47	75.0	4.69
Species Richness	101	99	104	92	92	89						
Simpson's Index	0.8618	0.8403	0.9160	0.9082	0.9539	0.8475						
Shannon's Index	1.0901	1.0113	1.1753	1.2359	1.4454	1.0292						

[a] Group 1 = Andrews and Hockley Counties, Texas; Lea, Quay, and Roosevelt Counties, New Mexico (*n* = 35 playas; 15,484 sample points).
Group 2 = Armstrong, Carson, Briscoe, Donley, Garza, Gray, Hansford, Hartley, Moore, Sherman, and Ochiltree Counties, Texas (*n* = 46 playas; 47,747 sample points).
Group 3 = Bailey, Cochran, Crosby, Deaf Smith, Floyd, Hale, Hutchinson, Lubbock, Parmer, Swisher Counties, Texas; Curry County, New Mexico (*n* = 87 playas; 67,534 sample points).
Group 4 = Castro, Lamb, and Randall Counties, Texas; Texas County, Oklahoma (*n* = 26 playas; 18,436 sample points).
Group 5 = Dawson, Howard, Lynn, and Terry Counties, Texas (*n* = 23 playas; 12,145 sample points).
Group 6 = Baca and Las Animas Counties, Colorado; Cimmaron County, Oklahoma; Dallam County, Texas; Morton County, Kansas (*n* = 16 playas; 11,253 sample points)

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